Formal Opening of the
ENGINEERING AND
PHYSICS BUILDINGS.

McGILL UNIVERSITY, MONTREAL.

FEBRUARY 24th,
1893.

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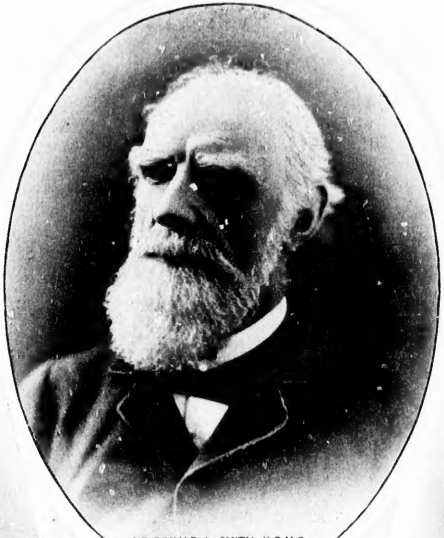


SIR DONALD A. SMITH, K.C.M.G.,
CHANCELLOR.

W. C. McDONALD, Esq., GOVERNOR.

THOMAS WORKMAN, Esq.

40536

McGILL UNIVERSITY,

MONTREAL.

Faculty of Applied Science.

SIR WM. DAWSON, C.M.G., LL.D., F.R.S., Principal.

HENRY T. BOVEY, M.A., D.C.L., LL.D., M.Inst.C.E.,F.R.S.C., Dean of the Faculty.

PROFESSORS.

B. J. HARRINGTON, B.A., PH.D., F.R.S.C.,
Greenshields Professor of Chemistry and Mineralogy.

HENRY T. BOVEY, M.A., D.C.L.,
Scott Professor of Civil Engineering and Applied Mechanics.

C. H. MCLEOD, MA.E., F.R.S.C.,
Professor of Surveying and Geodesy, Lecturer in Descriptive Geometry, and Superintendent of the Observatory.

G. H. CHANDLER, M.A.,
Professor of Practical Mathematics.

C. A. CARUS-WILSON, M.A., AM. Inst., C.E., M. Inst. E.E.,
McDonald Professor of Electrical Engineering.

J. T. NICOLSON, B.SC., M.AM.SOC.M.A.,
Workman Professor of Mechanical Engineering, and Lecturer in Thermodynamics.

ASSOCIATE PROFESSORS.

SIR WM. DAWSON, LL.D., F.R.S.,
Logan Professor of Geology and Professor of Natural History.

PIERRE J. DAREY, M.A., B.C.L., LL.D., Officier d'Academie,
Professor of French Language and Literature.

CHARLES E. MOYSE, B.A.,
Molson Professor of English Language and Literature.

D. P. PENHALLOW, B.SC., F.R.S.C.,
Professor of Botany.

JOHN COX, M.A., *McDonald Professor of Experimental Physics.*

LECTURERS

W. A. CARLYLE, MA.E.,
Lecturer in Mining and Metallurgy.

R. S. LEA, MA.E.,
Lecturer in Mathematics and Drawing.

NEVIL NORTON, EVANS, M.A.SC.,
Lecturer in Chemistry.

ASSOCIATE LECTURERS

PAUL T. LAFLEUR, M.A.,
Lecturer in English.

FRANK D. ADAMS, MA.SC., PH.D.,
Lecturer in Geology

L. R. GREGOR, B.A.,
Lecturer in German.

REV. J. L. MORIN, M.A., *Sessional Lecturer in French*

HOWARD T. BARNES, B.A.SC. *Assistant in Practical Chemistry.*

Brief Sketch of the History of the Faculty of Applied Science.

In an inaugural address delivered in 1855, Sir William Dawson pointed out the importance to the University of a department of practical Science.

In the following year T. C. Keefer, C.E., was appointed Professor of Hydraulic Engineering, but was called away from Montreal, without having entered upon the duties of his office. At the same time, Robert Crawford, B.A., was made Professor of Road and Railway Engineering, which position he held until the year 1857 when he was succeeded by Mark J. Hamilton, C.E., who held the post until the year 1865. The first graduate was Oliver Gooding, who, in 1858, received the diploma of Civil Engineer, and the total number of Graduates up to 1865, when the Department lapsed, was fifteen.

In 1871 the Department was re-established in connection with the Faculty of Arts, the special course of study required, extending over three years and leading to the degree of Bachelor of Applied Science.

The Professors and Lecturers appointed were G. F. Armstrong C.E., now Professor of Engineering in the University of Edinburgh; Dr. Harrington, Dr. Girdwood, and the late Dr. T. Sterry Hunt. Two years later, in 1873, C. H. McLeod, B.A.Sc., was added to the Staff. In 1876 Professor Armstrong resigned and was succeeded temporarily by C. A. Harris. In the December of the same year, Henry T. Bovey, M.A., Fellow Queen's College, Cambridge, was elected to fill the Chair of Civil Engineering and Applied Mechanics, and assumed the duties of his office in September, 1877.


WILLIAM C. MACDONALD, GOVERNOR
SIR DONALD A. SMITH, CHANCELLOR
SIR WILLIAM DAWSON, PRINCIPAL
PROF. H. T. BOVEY, DEAN
FACULTY
PROF. C. C. MOYSE
PROF. C. A. CARUS-WILSON
PROF. B. J. HARRINGTON
PROF. G. H. CHANDLER
PROF. C. H. McLEOD
A. T. TAYLOR
F. D. ADAMS
PROF. JOHN COX
WM. A. CARLYLE
L. GREGOR
PROF. J. T. NICOLSON
R. S. LEA
N. N. EVANS
PROF. D. P. PENHALLOW

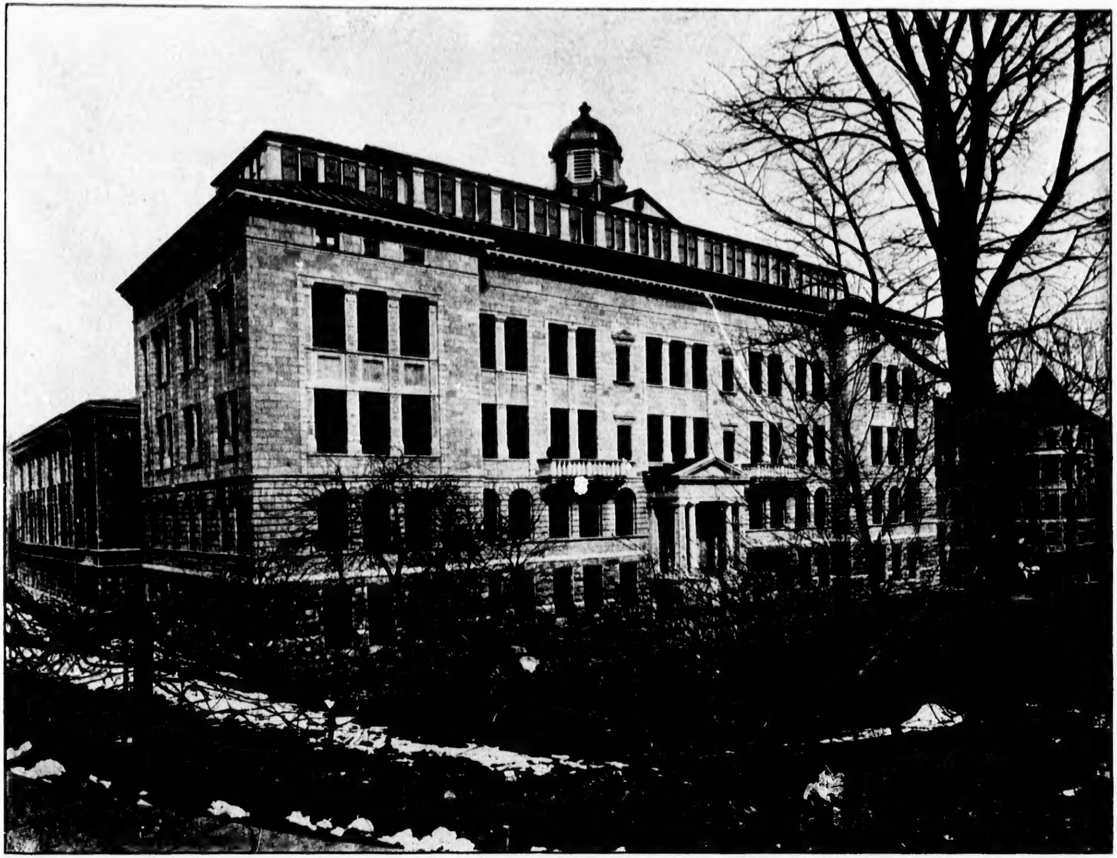
In 1878 the Department was separated from the Faculty of Arts and was constituted a Faculty of Applied Science, with Professor Bovey as Dean. The teaching staff consisting of Professor Bovey, Dr. Harrington, Dr. Girdwood and Professor McLeod, was now further strenghtened by the addition of G. H. Chandler, M. A., as Lecturer (now Professor) in Mathematics. The course was also lenghtened by adding to it a preliminary optional year, the complete course thus extending over four years and leading first to the degree of Bachelor of Applied Science, and subsequently to the degree of Master of Engineering, or Master of Applied Science. At this time twenty-eight students were attending the various courses, and the number increased to seventy-five in 1890. In that year a new career was opened up to the Faculty by the series of munificent endowments of W. C. McDonald and the late Thomas Workman, supplemented by the liberal gifts of other citizens, and the number of students suddenly rose to 125 in 1891 and to 175 in 1892.

Meanwhile the efficiency of the University teaching staff was considerably increased by the appointment of J. Cox, M. A., (McDonald Professor of Experimental Physics); C. A. Carus-Wilson, M. A. (McDonald Professor of Electrical Engineering); J. T. Nicolson, B.Sc., (Workman Professor of Mechanical Engineering); W. A. Carlyle, Ma. E., (Lecturer in Mining and Metallurgy); R. S. Lea, Ma.E., (Lecturer in Mathematics and Drawing); and N. N. Evans, M.A.Sc., (Lecturer in Chemistry).

The work of the Faculty was thus placed on a much broader basis. With well furnished Workshops and Laboratories equipped with the best and most modern apparatus for scientific investigations in all kinds of engineering, as projected, it was felt that it would be possible to train men who should acquire, by the carrying out of careful experiments, that confidence in their own powers, which is a necessity of success. The engineer of the past had been largely trained by the "trial and error system," as it may be called, and a very costly system it has proved. In fact he had been obliged to make trials for himself under all the disadvantages of isolation, and the lack of scientific guidance. Our knowledge of different forms of energy had greatly increased; new materials of construction were being introduced, and the demand for new effects was making the old rules insufficient or useless. Theory and practice had become so interdependent that an absolute connection between them was necessary for their advancement. In these new Laboratories it would be possible to supply a remedy for this state of affairs. In the Workshops also, the student would learn what good work was, how it should be done, and how long it should take to do it. He would therefore be fitted to direct and supervise with intelligence the work of the mechanic. Here too the student would become familiarized with machinery of the most modern and best types.

On October 25th, 1890, the corner-stone of our Engineering Buildings was laid by His Excellency, Lord Stanley of Preston, Governor-General of Canada. From that time the work was rapidly pushed forward. The Faculty took possession of each part as completed, and the Engineering and Physics Buildings were formally opened by Lord Stanley on February 24th, 1893. On that occasion a large number of distinguished guests were present from all parts of the continent, amongst whom may be mentioned: His Excellency, Lord Stanley of Preston, Governor-General of Canada; Sir Donald A. Smith, K.C.M.G., Chancellor of the University; W. C. McDonald, Esq.; Sir Casimir Gzowski, K.C.M.G., Ex-President of the Can. Soc. C. E.; Hon. Mr. Fielding, Premier of Nova Scotia; Sir Alexander Lacoste, Chief Justice of Canada; Hon. Mr. Desjardins, Mayor of Montreal; Hon. Mr. Ouimet, Supt. of Education; Dr. Henniker, Chancellor of the University of Bishop's College, Lennoxville; Rev. G. Grant, Principal of Queen's University, Kingston; Lord Kilcoursie, A.D.C.; Hon. Mr. Walsh, A.D.C.; Rev. T. Adams, Principal of the University of Bishop's College, Lennoxville; Dr. Howe, President of the Amer. Inst. of Mining Engineers; J. Birkinbine, Esq., Ex-President of the Amer. Inst. of Mining Engineers; Charles Macdonald, Esq., Vice-President of the Amer. Soc. of Civil Engineers; T. C. Keefer, Esq., C.M.G., Ex-President of the Can. Soc. C. E. and of the Amer. Soc. of Civil Engineers; E. P. Hannaford, Esq., President of the Can. Soc. C. E.; R. W. Raymond, Esq., Ex-President and Secretary of the Amer. Inst. of Mining Engineers; J. Kennedy, Esq., Ex-President of the Can. Soc. C. E.; Hon. Judge Davidson; Hon. Judge Doherty; S. Finley, Esq.; Sir Joseph Hickson; Hugh McLennan, Esq.; George Hague, Esq.; E. B. Greenshields, Esq.; R. B. Angus, Esq.; Prof. Barker, of the University of Pennsylvania; Prof. Egleston of Columbia University, New York; Hon. T. Guilford Smith, Regent of the University of New York; Hon. G. A. Drummond; Hon. Mr. Archambault; Dr. Selwyn, C.M.G., Director of the Geological Survey of Canada; Rev. Dr. McVicar; Rev. Dr. Barclay; Rev. Prof. Murray; Dr. Mason; W. H. Wiley, Esq., Treas. of the Amer. Inst. of Mechanical Engineers; Dr. Coleman of the School of Practical Science, Toronto; etc., etc.

The guests assembled in the Drawing Rooms, which had been prepared for the occasion, and the following addresses were delivered:—



ENGINEERING BUILDING.

A. T. TAYLOR, F.R.I.B.A., ARCHITECT.

SIR DONALD A. SMITH, LL.D., K.C.M.G.

Chancellor of the University.

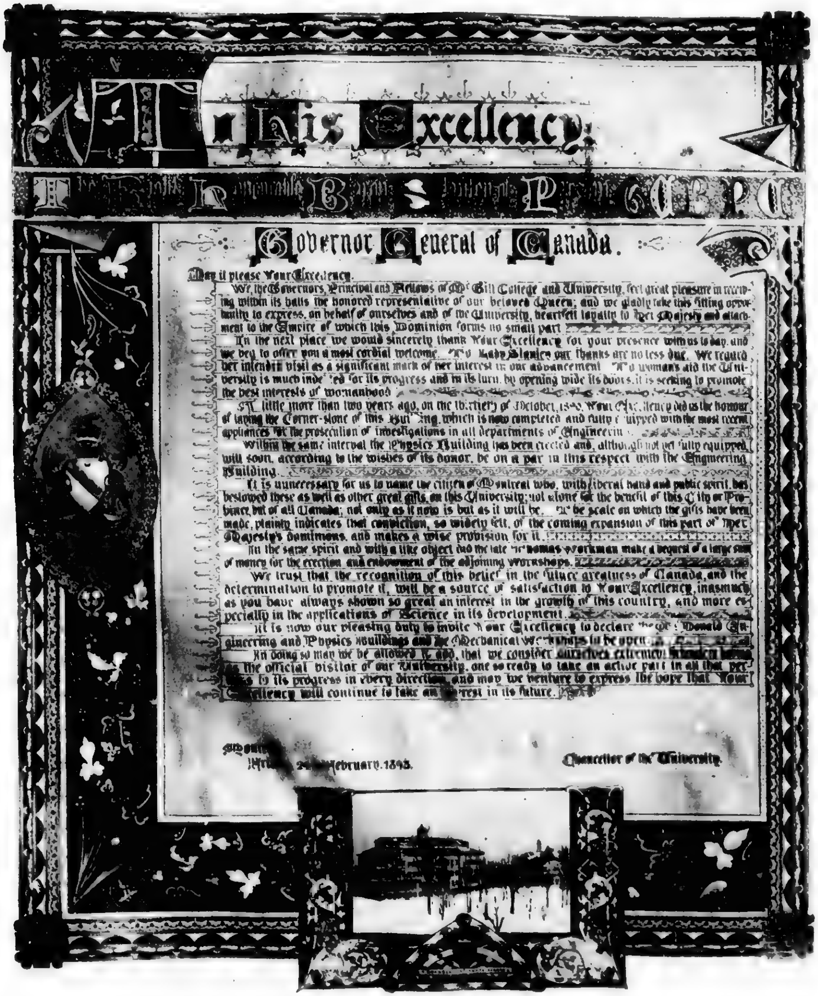
Having read the address which I now have the honour of presenting to you, there remains little further for me to do. I need hardly repeat that we feel highly honoured in having you here with us upon this occasion, not alone as representing our gracious Queen, but also as the Visitor of this University; and still again as one who having administered the government of the country under very trying circumstances for five years, has gained the regard and esteem of all Canadians. It is with deep feelings of regret, let me assure Your Excellency, that we think of the time, now rapidly approaching, when we must see you leave us at the end of your term of office. We also much regret that Her Excellency Lady Stanley is unable to be with us to-day, and it is with no little sense of relief that we learned of the removal of the load of anxiety which had pressed on your Excellency and on those dear to you.

Within the period from 1821 until the present time, seventy-two years, McGill University, from very small beginnings, has risen—we do not say it vauntingly, but we say it with the greatest satisfaction—to a standing on a par with the first universities, either in this country or in Europe. In its Arts Faculty it holds a high place, and we all know that for years past its Medical School has been regarded as one of the foremost rank. Until the present time the Faculty of Applied Science has not had the same advantages as some of the other faculties, but I am sure that Your Excellency, after looking over the buildings to be formally opened to-day, will admit that Montreal now possesses a school of practcial science unsurpassed anywhere. With the appliances now provided, and in the hands of the present professors, who are in every way capable of carrying on the work, the Faculty of Applied Science, we feel confident, has a great future before it. It is really unneccessary for me to enlarge upon the munificence and magnificence of the gift by means of which these buildings have been erected and equipped. At present I will only say that the heart of every Canadian, who takes an interest in science and in the advancement of learning, will go out to Mr. McDonald. It is a matter of much regret that our honoured Principal is not with us to-day, but it is a satisfaction to us, and a great satisfaction, to know that after a severe illness, brought on, doubtless, in large measure, by anxiety and by his devotion to the interests of this University, he is now convalescent. We trust that he will soon be restored to us in full health and vigour to resume those important duties which he has administered so long and so well.

It is a source of no little pleasure to see amongst us so many men distinguished in science and in literature from the United States and from all parts of the Dominion, and we welcome each and all of them most heartily. We are really delighted to have them here and to know that they will have an opportunity for themselves of seeing what is being done in McGill for higher education. While we welcome those who have actually come amongst us, we have a word of sincere regret that many who intended to be present have at the last moment found it impossible to come. It was the intention of the Prime Minister of Canada, and of several members of the Dominion Ministry to have taken part in these proceedings. General Walker of the Massachusetts Institute of Technology and Professor Thurston of Cornell University have been, I am sorry to say, detained by what we have occasionally even in Canada, a snow blockade. We had reason also to expect Presidents Gilman of Johns Hopkins, Low of Columbia, and Schurman of Cornell.

We are indebted, and very greatly indebted indeed, to a large number of friends in the United States, in Canada and in Europe, for the help they have given in adding to Mr. McDonald's magnificent donations. They have contributed valuable appliances to the engineering and other departments. We appreciate those gifts for their intrinsic value, but even more for the good-will towards us, and we heartily thank those gentlemen for what they have done. We also owe thanks to the Dominion Government and the Minister of Customs for the permission to have these gifts and the apparatus required for the buildings, entered free of duty. And this leads me to refer to one point which I think will commend itself not only to Your Excellency, but to every student. In the United States, Great Britain, France and other civilized countries, there is no tax imposed on books or on anything required for higher education. Representations on this subject have been made from time to time to our own Government. The Ministers no doubt, have seen difficulties in the way, but we are very hopeful indeed that in a short time we shall hear of that privilege being granted us which is so freely given elsewhere.

It is no light matter for Universities to pay this duty. While books are dutiable, a painting by a great master, although it cost $1000 or $100,000, is allowed to enter free. I would not have Your Excellency understand that I would suggest putting a tax on such paintings, seeing that they are great factors in raising the standard of civilization in any country, but it seems a hardship that while the person who is able to pay $100,000 for a picture, pays no customs duty, the student who may have severe struggles to provide for himself throughout his college course has to pay taxes on his books. However, we are most hopeful that the government will remedy this state of things in the near future. Your Excellency, I will now conclude by again expressing the gladness we all feel in welcoming you among us to-day.



To His Excellency

The Right Honourable Baron Stanley of Preston, G.C.B., P.C.

Governor General of Canada.

May it please Your Excellency.

We, the Governors, Principal and Fellows of McGill College and University, feel great pleasure in receiving within its halls the honored representative of our beloved Queen; and we gladly take this fitting opportunity to express, on behalf of ourselves and of the University, heartfelt loyalty to Her Majesty and attachment to the Empire of which this Dominion forms no small part.

In the next place we would sincerely thank Your Excellency for your presence with us to-day, and we beg to offer you a most cordial welcome. To Lady Stanley our thanks are no less due. We regard her intended visit as a significant mark of her interest in our advancement. To woman's aid the University is much indebted for its progress and in its turn, by opening wide its doors, it is seeking to promote the best interests of womanhood.

A little more than two years ago, on the thirtieth of October, [illegible], Your Excellency did us the honour of laying the Corner-stone of this Building, which is now completed and fully equipped with the most recent appliances for the prosecution of investigations in all departments of Engineering.

Within the same interval the Physics Building has been erected and, although not yet fully equipped, will soon, according to the wishes of its donor, be on a par in this respect with the Engineering Building.

It is unnecessary for us to name the citizen of Montreal who, with liberal hand and public spirit, has bestowed these as well as other great gifts on this University; not alone for the benefit of this City or Province, but of all Canada; not only as it now is but as it will be. The scale on which the gifts have been made, plainly indicates that conviction, so widely felt, of the coming expansion of this part of Her Majesty's dominions, and makes a wise provision for it.

In the same spirit and with a like object did the late Mr. Thomas Workman make a bequest of a large sum of money for the erection and endowment of the adjoining Workshops.

We trust that the recognition of this belief in the future greatness of Canada, and the determination to promote it, will be a source of satisfaction to Your Excellency, inasmuch as you have always shown so great an interest in the growth of this country, and more especially in the applications of Science in its development.

It is now our pleasing duty to invite Your Excellency to declare the McDonald Engineering and Physics Buildings and the Mechanical Workshops to be open.

In doing so may we be allowed to add, that we consider ourselves extremely fortunate in having as the official visitor of our University, one so ready to take an active part in all that pertains to its progress in every direction, and may we venture to express the hope that Your Excellency will continue to take an interest in its future.

Montreal,
Friday, 24th February, 1893.

Chancellor of the University.

MR. W. C. McDONALD.

May it please your Excellency, my duty on this occasion is a very simple one. It is merely to present to your Excellency the keys of the Engineering and Experimental Physics Buildings in order that your Excellency may declare both buildings formally opened for the educational purposes for which they have been erected. I hope your Excellency will be so good as to retain the keys in remembrance of the event.

Mr. W. C. McDonald then formally presented to Lord Stanley the keys of the Engineering and Physics buildings, in a box made of teak from the Beaver, the first steamship to round Cape Horn, the key of the Engineering building being made from the first metal tested in the laboratories.

HIS EXCELLENCY THE GOVERNOR-GENERAL OF CANADA

Visitor of the University.

The hero of the hour, with characteristic modesty, refuses to make any address, and has just now contented himself with presenting to me, as his only part in the ceremonies of to-day, the keys of this and the adjoining building, which we have assembled to open, and which we owe to his liberality. As I feel sure he would not wish me to go out of the course in endeavoring imperfectly to say that which he has purposely left unsaid, I will with your leave, proceed to answer, to the best of my ability the kind address of welcome which you, Mr. Chancellor have been good enough to present to me on the part of this University.

With regard to the opening portion, in which you speak of the pleasure with which you receive the representative of the Queen, it is happily no new thing for me to hear throughout the Dominion, and especially is it a phrase which I am well accustomed to, in what I may call my native University of McGill. Be assured that this amongst many other tokens of loyalty loyalty not only to the throne, but personal devotion to the Sovereign—will be presented by me in due course to Her Majesty, who never fails to take, as she has at all times taken, the deepest interest in all that concerns the welfare of those with whom she is connected, and especially her subjects in the Dominion of Canada.

The next paragraph I cannot but touch upon with feelings in which I am certain I have your deepest sympathy. It had certainly been Lady Stanley's intention to be present with me to-day, to have come amongst many friends whom she is always glad to meet, and to make her appearance once more at the University which has always received her with such significant kindness and with such great honour; but unfortunately, as you know, other causes have interfered, and though Sir Donald Smith has referred to the great part which ladies are taking in the university course here, and to their close connexion with it, I think I can offer a sufficient apology for Lady Stanley's absence by saying that in going to nurse a son who is dangerously ill she is performing her womanly duties in a manner no true woman could disapprove of.

Well, gentlemen, I may now pass on, with very little more preface to the paragraph in which you were good enough to remind me that I saw this building in its earlier stages. Rather more than two years ago we stood outside upon a not very sultry afternoon and laid the foundation-stone, which I trust had not like many other foundation-stones, to be surreptitiously taken up and relaid by the masons in the dead of night. When we laid it no one could have anticipated that in such a short space of time we would have stood in this building and in the adjacent one and have seen the completion of the wishes of the kind and munificent donor, to whom it must be a happy day to see his brightest hopes so completely realised and his work so fully appreciated by so many of the community, young and old, who have joined to-day in doing him honour. Now, I am afraid, as very often happens to men in public life, I find myself called upon to speak of that of which I know comparatively little. It is true that upon my arrival in the city last night, I had an early opportunity of meeting the Dean of the Faculty of Applied Science, who, I venture even in his presence to say, reminds me, as well as anything can remind one, of what one has never seen, and never will see perpetual motion personified in the flesh. He was kind enough to ask me to go and look at some of the equipment of this building, and though the time was short, I hope we were able to make the best use of what remained at our disposal, and a most interesting time it certainly was for anyone who can foresee the noble purposes which this great building may serve. I believe that the munificent donor, though he has carefully concealed, and probably will continue to conceal all such matters from me, would not be in a position to deny that probably it will be nearer seven than six figures which have been reached before his benefactions are completed. I must say it has been my good fortune to see many installations of modern science. Whilst only partially comprehending them, I think I am in a position to affirm that I have never seen anything equal to the completeness and liberality with which all the necessary plant has been put into this building. I believe it is a secret which I am at liberty to break, that when a question came up as to this or that appliance for making some particular test, it was not sufficient to say: "Here is this or that in use, which is good enough for the purpose." Such a suggestion, if ever it was

[illegible] with the injunction "Don't get only what will do; but the best that is to be got." Now, I am not going, for very obvious reasons, to [illegible] the congenial field of what were my discoveries last night, nor to speak of the beautiful electric plant and other magnificent machines, [illegible] which, a testing machine, was of such dimensions and force that it foreshadowed the necessity referred to in the address of your Chancellor [illegible] spoke of the duty on books; it must have been big enough and strong enough to test the National policy. Then wandering into [illegible] department of steam, subject to the usual annointings of tallow and other similar lubricants, there is an engine which, I believe, will [illegible] source of endless satisfaction to my friend the Dean, because you can take it to pieces in about sixteen different ways, and if you [illegible] it you will be a very wise and competent man indeed. He pointed out with pride that there are also about it sixteen indicators; [illegible] him, like a skilful Chancellor of the Exchequer, to manipulate his figures so that when he brings out the result of his experiments [illegible] agree with the fact, so much the worse for the fact. But, speaking in all seriousness, I do believe there can be had in this building [illegible] thorough introduction into all departments of engineering science. You all know what a great country we have, -you [illegible] to satiety; but all the same it means there is a great country remaining to be developed and conquered, in which [illegible] may lay out new roads for commerce and civilization, and in which the hydraulic engineer will find problems [illegible] tax his highest science and give him the greatest possible opportunities. You are being instructed, not for the amusement [illegible] with a view to making you intelligent and active members of your profession, one of the greatest and most useful which the [illegible] at the present moment. On this continent the problem is somewhat altered from what it was in other lands, where men, following [illegible] the natural destructive instincts of childhood, devoted their earliest engineering efforts to the destroying of human life. Here, [illegible] occasional accidents happen, such as occur in all professions, the object of the civil engineer is rather to promote the saving of life than [illegible] In the older countries the military engineer led the way, opened up roads, navigated rivers, and connected by various lines [illegible] it might be of a widely scattered region. The problem here is of a more peaceable character, but you have, nevertheless, great and [illegible] battle with, and the experiments which can be conducted here, and which I hope will be conducted for many years to come, will [illegible] and teach you both in the principles and practice of the best mode of overcoming such difficulties. My esteemed friend, the Dean, [illegible] to conduct me yesterday into a room which at first appeared as if it were intended for his private swimming bath. Perhaps it may [illegible] that did not transpire. But it is fitted with appliances to test and gauge carefully the effect of the discharge of water under different [illegible] from differently shaped orifices; to gauge the flow over weirs, to discuss the different conditions of varying pressure, and to render [illegible] very best and most admirable scientific means for determining those matters which many an engineer has had the utmost difficulty in [illegible] perhaps imperfectly, for himself. In a similar manner, in electrical science there appears to be every arrangement for gauging currents [illegible] for recording the voltage, and for the measuring of it in amperes under varying conditions. It is not for me to speak of a problem [illegible] be occupying a great many minds: how far forces can be centralized at certain points, and how far, either by electrical power or by [illegible] can be transmitted to a distance. In other words, how far it may be possible, for the general benefit, to harness Niagara, or make [illegible] at Lachine. But these are all problems which are very real. In these days of discovery all the so-called little details made known [illegible] become useful to the whole world. The elements of many of the finer machines, the phonograph, the telegraphic recorder, etc., [illegible] perhaps thirty or forty years ago; but, perhaps, the one point required to make them of practical use was wanting, and therefore those [illegible] as they may be, have remained undeveloped until the present. There again is perhaps a point which I think we may well bear [illegible] that in knowledge as in materials, if we store away something for which we have no present use and keep it long enough a time [illegible] when the information will be of value. And I doubt not that in this building, thanks to the munificent gift of Mr. McDonald and the [illegible] he has equipped it, there will be thoughts struck out in the minds of those working here which may be productive of discoveries [illegible] Canadian science. Now, gentlemen, I am sorry to say that like many persons I am afraid I have been carried away by the [illegible] I don't know if any of you remember in one of Leech's comic pictures of life and character the portrayal of one of the [illegible] hemmed round with canvas, and two or three little children lying flat upon the ground peering underneath the canvas, and one [illegible] lovely here! Come and see the heels of the horses!" I always feel somewhat like that when talking of science. It is such an [illegible] that when I come near a man of science I fear I am tempted to think I can see "the heels of the horses." My thanks are due to [illegible] patiently listened to me. I would add one remark, to join in the genuine regret you have expressed in regard to the absence of [illegible] Principal, Sir William Dawson. It is indeed sad that he is obliged to remain away on a day which I am sure would have given him [illegible] May I as a visitor suggest that he would be gratified if we collectively sent him a telegram of condolence and announced the [illegible] proceedings? I am glad, as one of yourselves, to welcome so many distinguished visitors from the other side of the border; and though [illegible] reference made to a snow blockade, let me beg them to carry to the authorities of the United States, when they return, the humble

assurance of a person diplomatically interested, that the Dominion of Canada was in no way concerned in that blockade, that it is entirely of an uncommercial character, that, still more, though Canada's responsibility, no doubt, is unquestioned, the whole of the occurence seems, as sometimes happens, to have taken place in the territory of the United States; and last, but by no means least, I trust it will not be added to the many diplomatic excuses which I have to make sometimes in the best spirit I can. We are always glad to welcome men of science from the other side of the border, to show them what a good and thriving neighbour they have in the Dominion of Canada, and to assure them that whoever speaks as the representative of the sovereign will feel that he is voicing the heart of the Dominion in giving them on all occasions a most cordial welcome. We trust, moreover, with conscious pride that before the day is over they will own, if not in public, at least in their own hearts, that perhaps even the Massachusetts Institute of Technology or Cornell could not surpass some of the work which they will see here. This is, indeed, high praise, for nowhere have more noble benefactions been made than in the United States, and nowhere have they been made better use of. I have only one topic more of which I took a note just now, and that is with regard to the by no means unimportant subject of free books. I have been so much hauled over the coals, or other persons for me, for having received gentlemen in private conversation, who spoke to me about business in which they were interested, that I fear, as there is no Minister of the Crown present, though I dare say many future ones, that I can only take notice of the subject and refer it to my constitutional advisers; but be assured if such a topic should come up, and I think it is not impossible, I shall speak, not as the Governor-General, but with a recollection that I am one of yourselves, a fact of which this gorgeous, but if I may say so, slightly inconvenient garment, the college robe, reminds me, notwithstanding the deep honour which I feel at all times in wearing it. Well, now, ladies and gentlemen, I have kept you long enough. I know there is one gentleman who has been desirous of experimenting in science, for I caught a sound just now which led me to believe the acoustics of the building were about to be tested. However, be that as it may, I can only thank you once more for the kindness with which you have always greeted me here. From the Chancellor down to the newest undergraduate you have all made me one of yourselves; and they are no idle words I speak when I say that should this be, which may be or may not be, the last occasion upon which I speak to you within these walls, I can only reiterate a sentiment which will last to my dying day, a sentiment of cordial thanks to the University of McGill for the kindness which one and all have always shown me, of undying interest in its future success and honour, and of gratitude which will only end with my life.

REPRESENTATIVES OF THE UNDERGRADUATES

Mr. J. A. MacPhail, fourth year, Mr. J. H. Featherston, fourth year, and Mr. Gill, first year, now came forward, and Mr. MacPhail read the following address on behalf of the undergraduates.

To His Excellency the Right Honourable Baron Stanley of Preston, G. C. B., LL. D., Governor-General of Canada:

MAY IT PLEASE YOUR EXCELLENCY:

It seems fitting that the undergraduates, for whose direct benefit these magnificent and splendidly equipped buildings have been constructed, should present an address to Your Excellency on this occasion. Owing to the munificent donations of Mr. W. C. McDonald and Mr. Thomas Workman, the students in Applied Science feel that their Faculty now gives a course of scientific instruction equal to any furnished in the most advanced Institutions of this Continent or of Europe. The present flourishing condition of the school is a happy augury of still further developement in the immediate future, and the students venture to express the hope that what has been so auspiciously begun, may lead to other foundations as generously conceived and as effectively planned as these, which will always be gratefully connected with the names inscribed over their portals.

It is gratifying to direct the attention of Your Excellency to the fact that graduates of this school have already attained distinction in the world of practical science, and it is more gratifying still to attribute such success in large measure to the careful training received in McGill University. Many of the students in whose name this address is presented were assembled two years ago when Your Excellency laid the foundation stone of this building, and they congratulate both the University and their own Faculty on an event which enables Your Excellency to witness, after so brief an interval, a developement of one of the departments of McGill University which, they believe, has not been surpassed in the academic history of this continent.

The students regret that the effects of a severe illness have prevented the Principal of this University, Sir William Dawson, who has always taken so great an interest in the welfare of this Faculty, from being present to-day, and they feel that they utter a sentiment which Your Excellency shares, when they express the hope that Sir William may return to the University with renewed health and vigour. The students in Applied Science are thankful for the deep interest which Your Excellency has already shown in the progress of the University, and they trust that the successive representatives of the Queen in this Dominion will evince toward the University feelings similar to those which have prompted Your Excellency to be present here to-day. In conclusion, the students of Applied Science beg to express the hope that continued health, honour and prosperity will fall to the lot of Your Excellency and of Lady Stanley of Preston, whose absence from the day's ceremonies is deeply regretted.

Chairman of Com., J. H. FEATHERSTON,
President of 4th year, J. A. MACPHAIL,
President of 3rd year, A. R. HOLDEN,
President of 2nd year, W. F. ANGUS,
President of 1st year, G. ALLEY,
Secretary of Com., L. A. HERDT.

MR. J. H. FEATHERSTON

The students of Applied Science deeply regret the absence of Lady Stanley, and beg that you will do them the honour of accepting on behalf of Her Excellency a small cabinet made in the workshops by an undergraduate of the first year, Mr. Gill, which I now have the honour of presenting to Your Excellency.

HIS EXCELLENCY THE GOVERNOR-GENERAL

I owe you an apology, gentlemen, for addressing you a second time, after having prolonged my previous remarks, but I cannot on the other hand, feel that I should be discharging my proper functions if I were not to thank you sincerely for the kind words in the address which you have presented on the part of the undergraduates. You have been always good enough as I have already said, to make me one of yourselves and to allow me to identify myself as far as I could, with that which concerned you, whether inside the class-room or outside, and I thank you once more for this evidence of your good feeling. I can only regret that Lady Stanley is not present to receive the cabinet which you have so kindly given to me for her, for I am sure she would have been most deeply touched, both at the thought and the manner in which the presentation was made. I am not without hope that in passing through again, perhaps only informally, the gentlemen who have made the presentation to-day, if they are still here may call upon me when Lady Stanley returns, and place the cabinet in her own hands themselves. Perhaps this is rather a simple-minded remark after nearly thirty years of matrimony, but I think that is the highest honour I can confer upon them. However, leaving arrangements as they must be left, to the future, I thank you once more for your kindness towards her which she will very deeply appreciate. I share with you your regret at the absence of Sir William Dawson from this meeting to-day, as it would have given him extreme pleasure to have been present. I have never seen anyone who at all times, identified himself more thoroughly with the University and with the life of the undergraduates. I have spoken so much of matters which are cognate to this address that I won't go over the same ground a second time. I have spoken of hydraulics in a serious sense, but I hope, though I saw no provision for it below, that there will be included that branch commonly known as aquatics, and I trust, that dynamics or the laws of motion may not be altogether forgotten in the football field. As to the transmission of force, which is a point upon which, perhaps there is a little more difficulty in touching, I hope that, as on all occasions McGill does its best, and successfully does its best to come to the front, it may be yours, first of all in your undergraduate course, and afterwards in the direct race of life, to press forward as you would in the sports or in the class-room; to remember, when you are in doubt or in difficulty, how many honest and true hearts have been closely linked to you here, and whatever your fortune in life may be, be it good or medium, at all times to remember to conduct yourselves as true citizens of the Dominion and as worthy undergraduates and sons—I can find no higher terms—of your Alma Mater McGill.

THE HON. W. S. FIELDING,

Premier of Nova Scotia.

Be assured I appreciate too highly the honour which has been extended to me, in the mention of my name as one of your guests, to so far abuse your confidence as to detain you for more than a few moments. I come to join in the congratulations upon this new evidence of the prosperity of McGill. Although I have no special commission to do so, I know that if to-day I could be in touch with the governing bodies of the various educational institutions in Nova Scotia, I should be authorized to say that they join heartily in these congratulations, and wish you even greater prosperity in the future. Perhaps we in the Maritime Provinces are disposed to complain at times because you take away some of our men. Our own colleges are doing good work, but we have to admit that there are some advantages not within their reach which can be obtained by a student at Montreal. Apart from the general interest which every good citizen of the Dominion should feel in this great University of McGill, there is a special reason why a Nova Scotian should be proud of it, for we know that at its head we have a distinguished Nova Scotian, Sir William Dawson, whose absence to-day we all regret. Close by me on the platform sits another distinguished countryman of mine, who has been drawn away from our own Province to fill the position of President of a great University in Ontario. We rejoice in his good work, yet I must confess that I should have greater pleasure in finding Rev. Dr. Grant at the head of one of our own institutions. And when I find how much has been done and is being done for McGill by the citizens of Montreal whose princely generosity has given you these buildings may I not be permitted to derive a little additional pleasure from the fact that he, too, is a Maritime Province man. It is gratifying to us to know that if you take many of our men away from us you make very good use of them. There is one thought in connection with educational work which a meeting like this is calculated to impress upon us. We sometimes hear it said that there is too much education in the country. That is an awful thing to repeat within the halls of McGill. But such a thing is said, and not always by men who are ignorant. It is said that the vast sums of money which have been spent on education throughout Canada, have, in many cases, not been well spent. What is really meant by such criticism, I take it, is not that there has been too much education, but that education has not always been directed in the line which would make men best qualified to meet the actual requirements of our condition. I would not be understood as sympathizing with those who undervalue the Classical side of education. Those whose time and means permit them to study the Classics are all the better for it. But when we look at the country in which we live and its magnificent possibilities, I think we must see that the scientific and practical side of education must be more prominent in the future. The splendid Engineering and Physics buildings, which we have seen to-day are evidences of the recognition of the fact. I join most heartily in the congratulations to the Governors of McGill on this auspicious occasion, to Mr. McDonald whose liberality has done so much, and to the citizens of Montreal on the fact that they have among them so many who are ready to contribute their wealth for the advancement of knowledge in the Dominion of Canada.

LIBRARY.

SIR ALEXANDER LACOSTE,

Chief Justice of Canada.

I fully appreciate the honour of having been invited to be present at this festival, but I must admit that I consider it to be a greater honour to be called upon to address this gathering, although I confess that it is somewhat trying for me to speak in a language which is not my own, and without any warning. When it is the will of God the seed which is thrown into the earth becomes a great tree. I believe that this university is favored of God. Those generous men who have done so much for it have not done good to mankind only during their life, but for generations and centuries after their death. Who can fully appreciate the good work done by Mr. McGill? Who can foresee what benefit this country will derive from these very buildings fifty or a hundred years hence? I feel it my duty to join my voice with those who have spoken before me, in expressing the gratitude of the citizens of Montreal and the gratitude of the people of the Dominion to the noble donor of these buildings. I wish the French university in Montreal had been as successful as McGill. Is this due to the bad quality of the soil? Is it due to a want of generosity? Is it due to the fact that Providence has been less bountiful towards us of its wealth and riches? I dare not say. However, the nation is One, and those who add to its greatness must be true to all.

THE HON. SENATOR DESJARDINS

Mayor of Montreal.

Whenever my name is coupled with the mayoralty I become uneasy. It has had that effect upon me for the past few months but never to the extent I feel it at this moment. I have to offer, like Sir Alexander Lacoste, but with much more reason, the excuse that the English language is not familiar to me. I am not like His Excellency, who, the papers informed us, lately visiting different parts of the country, whenever an address was presented to him, be it in Latin, German, English, French or any other language, had an answer always ready in that particular tongue. Well, I admire, but I cannot imitate Your Excellency. Let me say in the name of the city of Montreal, since I am authorized to speak in its name, that we are grateful for your presence at this happy ceremony. We know under what trying circumstances you were expected to be here, and we fully appreciate your presence. We of Montreal are proud of this great institution of McGill. We are proud of it not only as citizens of Montreal, but as Canadians. We feel that the benefits which it is conferring upon the youth is not only a benefit conferred upon Canadians, but it is a benefit to the world. We are pleased to have amongst us so many of the distinguished Engineers of America. We are pleased to show them that if, from the beginning of the Republic, their patriotic, their most prominent men, have always been anxious to see the cause of education promoted, we on this side of the line, in perhaps a more humble way, have always had the same object in view. We, like them, have been anxious that youth should find within our limits all that was necessary to bring it abreast of the youth of any other country. Nothing will make a person so self-reliant as the knowledge of the fact that in his own country he can find everything he wants for success in life. The opening of these buildings meets a want. We have not been behind any other country in the promotion of classics, but in the past fifteen years this country has developed and the need of new requirements has been felt. We have found that, while our classical education was sufficient to form ministers of religion, lawyers and doctors, other fields of great importance were opening before the young men of the country, and we were anxious that when great public works were to be constructed we should not have to borrow, as we have been obliged to do for many years, capable engineers from other countries to help us, but that we should find in Canada, men able to undertake the work. It is, therefore, cause for great gratitude to the donor of these buildings that he has put at our disposal just what we wanted to supplement that deficiency. Let me quote to you the words said of a man to whom the United States is deeply indebted, James Smithson, an English-born citizen, the founder of the Smithsonian Institute. Prof. Richards, alluding to the words by which James Smithson donated his princely gift to the United States, said: "If a man has contributed his mite to the increase of knowledge, if he has diffused that knowledge for the benefit of man, and, above all, if he h[illegible] applied it to the useful, or even to the ornamental purposes of life, he has laid, not his family, not his country, but the world of mankind under a lasting obligation." Such will be the feeling of this audience towards our public benefactor. Not only McGill but Montreal as a whole, and the whole Dominion, will always retain a happy remembrance of the benefactors who have passed away. But we rejoice that those benefactors who are still living can see the good results of their good deeds, and we wish them happiness as they have been conferring happiness upon their fellow-citizens.

DR. ALEXANDER JOHNSON, F.R.S.C.

Vice-Principal, McGill University.

This is a day of rejoicing for the University and I can say in the name of the University that we are grateful to those who have come to share in our joy. This is the crowning day of the Faculty of Applied Science, which after a long and severe struggle has at length been placed on a firm basis. Its endowed professorships provide for that first and vital necessity, the means of teaching. The McDonald Engineering Building which you see, with its ample supply of apparatus and with machinery on so large a scale that it cannot fail to excite the admiration of even the unprofessional visitor, place it high, I think, among the scientific institutions of the world. No one can know fully the pleasure which this affords us, but those who have some idea of the severity of its struggle for existence. It began with a single professorship in the Faculty of Arts and owes its origin to Sir William Dawson, who built it up with pain and difficulty. His absence owing to ill-health, furnishes that measure of sadness which so often mingles with human pleasures. We cannot but deeply regret his inability to be present. At this moment he is probably thinking of the proceedings in this University, of which he may be called the Builder, as the Hon James McGill was the Founder. Allow me to read a letter I received from him a few days ago: –

ST. AUGUSTINE, FLA., Feb. 15th, 1893.

Dear Dr. Johnson,

It is a matter of deep regret to me that I should be an exile in the South on the occasion of the formal opening of the new buildings presented to the University by Mr. W. C. McDonald. This I feel the more that ever since my connection with McGill began it has been a prominent object with me to secure the best means of education in natural and physical science in the Faculty of Arts, for the benefit of students entering into any of the professions, and to develope the Faculty of Applied Science into a complete and efficient technical school. The benefactions of Mr. McDonald, added to those of Mr. Peter Redpath and Mr. Thomas Workman, now seem to place all this within our reach, and I trust that the celebration on the 24th will worthily inaugurate these new departures, so creditable to Canada and to McGill, and so likely to be loyally promotive of our advance in science and its applications. With all good wishes and kind regards.

Yours sincerely,

J. W. DAWSON.

His Excellency has kindly suggested that a telegram might be sent from this meeting. I would, therefore, propose that the following, of which His Excellency has approved, be despatched:

The University, including His Excellency the Governor-General, and its friends, assembled at the opening of the Engineering and Physics Buildings, send greeting to the Principal, with regret at his absence and the heartiest wishes for his speedy restoration to health and return to its halls.

(Signed), DONALD A. SMITH,

Chancellor.

A telegram was received subsequently from Sir Wm. Dawson, conveying congratulations and good wishes to the University, His Excellency and Mr. McDonald.

Sir William has written of some of the generous benefactors of this University, and of recent donations. I have referred, as yet, to one only of the great gifts that we formally receive to day. The other, the McDonald Physics Building, which will be opened this afternoon, comes to us at a most appropriate time because of the close and intimate connection which must necessarily be maintained between the Faculties of Arts and Applied Science, each of which can help the other, while maintaining that proper division of labor which is the secret of so much of the success of modern industry. There are not many who can appreciate this more fully than myself, for I was a member of both Faculties for many years, and have only recently withdrawn from the department of Experimental Physics. The growth of my work has compelled this, but I have quite enough of the Physics remaining in my charge to give me a lively interest and a fair share in the new building. The external relation that exists between the two faculties, or between the two buildings, is that between science and applied science. Science belongs especially to the Faculty of Arts, while its applications form the field of the other Faculty. But the dividing line is sometimes difficult to draw, and the applications of science re-act beneficially on the parent science itself leading to new advances in both. The connection is obvious enough in most of the sciences. It is strikingly so in the case of Electricity, where the names of the men who laid the foundation of the science from which we have such wonderful practical applications are stamped ineffaceably on the units employed for practical measurements. Volta, Ohm, Ampere, Weber, Faraday and others are there, well commemorated, though perhaps our electric lights and electric cars may more frequently bring Faraday to our mind.

We deem it part of our good fortune my lord, that you, who represent her Majesty, should have honoured us with your presence on this occasion. This University derives its authority directly from the Queen, and its degrees are recognised therefore not only in this Province, to which a provincial charter would limit them, but over the whole British Empire. The connection is very close with the Governor-General. Your Excellency, as Visitor, has very marked authority in this University, a fact that not many are acquainted with,

and concerning which I had to write to a high official in another part of the Dominion within the last ten days. Without your consent no professor can be appointed. Without your consent a professor cannot be removed. To Your Excellency the University annually submits a report of all its doings. These and other things result from the enactments of the royal charter granted by Her Majesty, who reserves to herself power of revision in all matters. The members of this University have then more than the usual reasons for that attachment to Her Majesty which is common to all true Canadians and Your Excellency may be assured that with them, as with the rest of Canada, loyalty is a feeling deeply seated in the heart. It may not make much show on every small occasion, but it is real and earnest. It is not a loyalty that depends on the price of eggs. But while we are loyal to our Queen and respect ourselves, we are most friendly to our neighbours; as friendly as to one another. How shall we thank those scientific friends from the United States who have come at such considerable inconvenience, often from long distances, to show their fellow feeling on this occasion. The expression of their sympathy is of the highest value to us on this account if no other, that they can in many cases enter very fully into our feelings; for though the advances of science with them have been remarkable within the last twenty-five years, yet there are probably many among them who have gone through an experience similar to our own, though not so recent. Everyone knows how much the assemblage of men with the same tastes tends to excellence in their common pursuit, and so their presence to-day must prove highly inspiring to us who stand later in the race, yet seek to attain as high a standard in turn. Science is of no country, and every truly scientific man rejoices in its advance, wheresoever it may be made. Yet I think scientific men are subject to some of the frailties of other mortals, and would if the choice were given them, prefer that a grand discovery or invention should be made in their own country rather than elsewhere, and, if they did not make it themselves that their friends should make it. For example, we in Canada would have been very proud if we had had the proper equipment and had been able to make that glorious discovery made by Professor Barnard at the Lick Observatory of the fifth satellite of Jupiter, which links the most recent history of telescopic astronomy with its very beginning 283 years ago. But as it is not a British triumph we are delighted that it should have been attained by those who come nearest to us in blood, by men not only of the same language, but of the same thought and feelings, and I am afraid I must add, for it also is a strong bond of union, the same prejudices as ourselves. Of course we do not recognize them as prejudices. All these causes strengthen friendship, as was recognized by the Roman historian more than 1900 years ago, when he said "idem velle," i. e., the same tastes and aspirations, "ac idem nolle," the same dislikes and prejudices, "ea demum firma amicitia," these form a firm friendship. And these bonds we have.

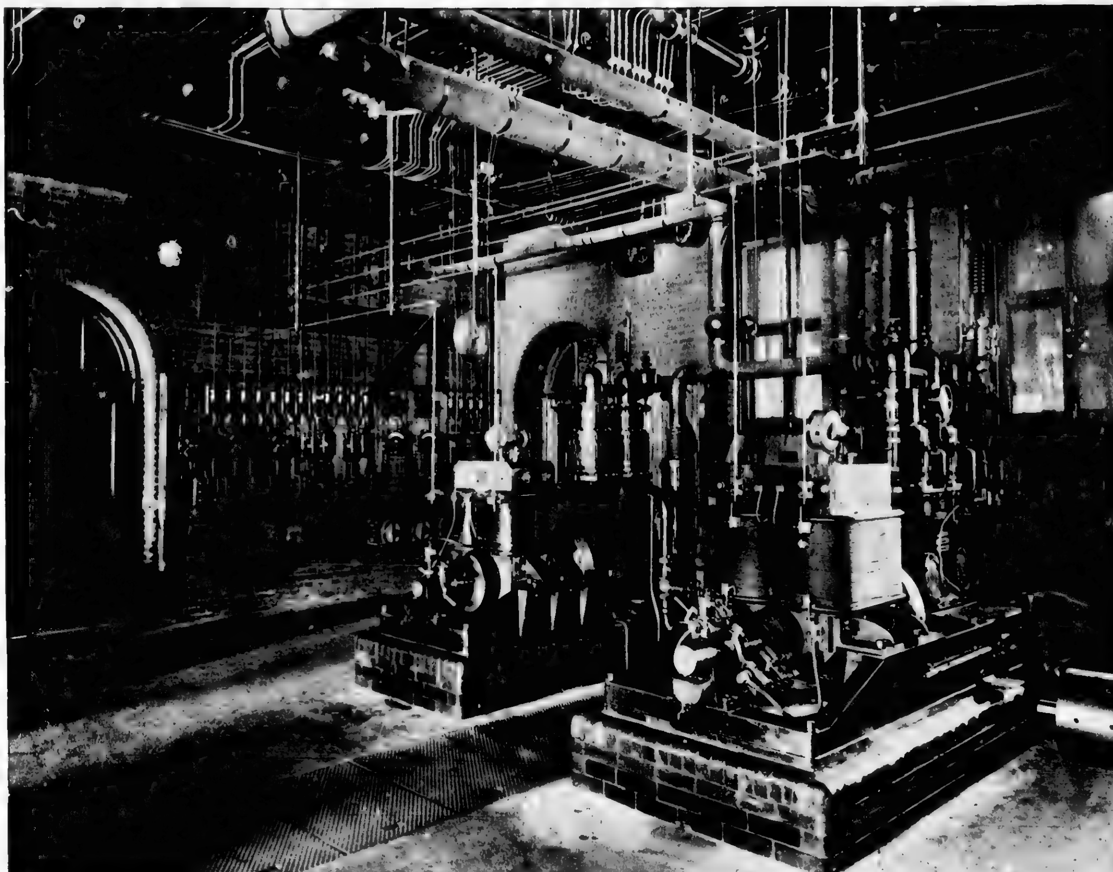
*GENERAL FRANCIS A. WALKER, Ph. D., LL.D.

President of the Massachusetts Institute of Technology.

I bring the heartiest congratulations of the Massachusetts Institute of Technology, to the officers and teachers of McGill University, and especially to Dr. Bovey, upon the fortunate completion, and the present auspicious dedication to their uses, of these commodious and superbly equipped laboratories of physics and engineering. The distinguished position which this University has long held in science and in the applications of science to useful arts, cannot fail to be greatly advanced as the result of these noble benefactions of Mr. McDonald The growth of scientific and technical schools on this continent during the past thirty years has savored of the marvelous. In part it has been due to the changed ideas and the transfigured ideals of the great American people; in part to the recognized need of greater skill and more of scientific knowledge for the development of the natural resources of the continent and for the direction of its growing enterprises. In this movement of the age, even the older institutions have been compelled profoundly to modify their traditional courses of study, substituting scientific and even technical instruction for much that was formerly deemed essential to a liberal education.

Of the reluctance, and even resistance which this movement has encountered from many who deservedly held high places in the old educational order, I would not speak with harshness. The notion that scientific work was something essentially less fine and high and noble than the pursuit of Rhetoric and Philosophy, Latin and Greek, was deeply seated in the minds of the leading educators of America a generation ago; and it has not yet wholly yielded to the demonstration offered by the admirable effects of the new education, in training up young men to be as modest and earnest, as sincere, manly and pure, as bright and appreciative as were the best products of the classical culture, and withal more exact and resolute and strong. We can hardly hope to see this inveterate prepossession altogether disappear from the minds of those who have entertained it. Probably these good men will have to be buried with more or less of their prejudices still wrapped about them; but, from the new generation, scientific and technical studies will encounter no such obstruction, will suffer no disparagement.

Another objection which the new education has encountered is entitled to far more of consideration. This has arisen from the sincere conviction of many distinguished and earnest educators that the pursuit of science, especially where its technical applications are brought strongly out, loses much of that disinterestedness which they claim, and rightly claim, is the very essence of education. For the spirit of this objection I entertain profound respect. I only differ from these honorable gentlemen in believing that the contemplated uses of science, whether in advancing the



LIGHTING STATION.

condition of mankind or in promoting the ulterior usefulness, success and pecuniary profit of the student of a technical profession, do not necessarily impair that disinterestedness which, I fully concede, is essential to the highest and truest education of the man. These gentlemen appear to me to have an altogether unnecessary fear of the usefulness of science. They entertain much of that dread of Fruit, which Macaulay in his famous essay on Bacon, probably with something of exaggeration as his custom was, attributed to the old philosophers.

I am willing to admit, that, in my humble judgment, many technical schools have erred in addressing themselves too directly and too exclusively to the purely practical side of instruction; that they have, in some degree, neglected principles, even in the study of science, and have borne an undue weight upon mere knacks and labor saving devices and technical methods. I believe that in doing this they have made a mistake, even from their own point of view, and with reference to the very objects they profess. Moreover, I am free to acknowledge, that, in my humble judgment, those who direct many technical schools have made a mistake in altogether, or nearly so, throwing out philosophical as distinguished from scientific, liberal as distinguished from exact, studies from their curriculum. Those technical schools will best accomplish their purposes of usefulness, alike to their students and to the state, which make more of the sciences than of the arts, more of principles than of their applications, and which offer to their pupils, in addition to those studies which make them exact and strong, some of those studies and exercises which will help to render them at the same time broad and fine.

With only such a subordination of technical and scientific studies as is for the greatest ultimate advantage of the technical professions themselves, and with such complementing of scientific by philosophical studies as has been indicated, I believe that the work of the student in schools of Technology is as fully entitled to be termed disinterested as that of a student in a classical college. In neither class of institutions can or ought the student to be unmindful that his personal success in life, and his professional and social position are largely to depend upon the manner in which his work shall be done in college. All that can be asked in regard to any school is that there shall be zeal in study, delight in discovery, fidelity to truth as it is discerned, high aims, and intellectual ambitions which have not sole or primary respect to material rewards. The strong desire to become a useful man, well equipped for life, capable of doing good work, respected and entitled to respect, constitutes no breach of disinterestedness in any sense of that word in which an educator would be justified in using it with commendation.

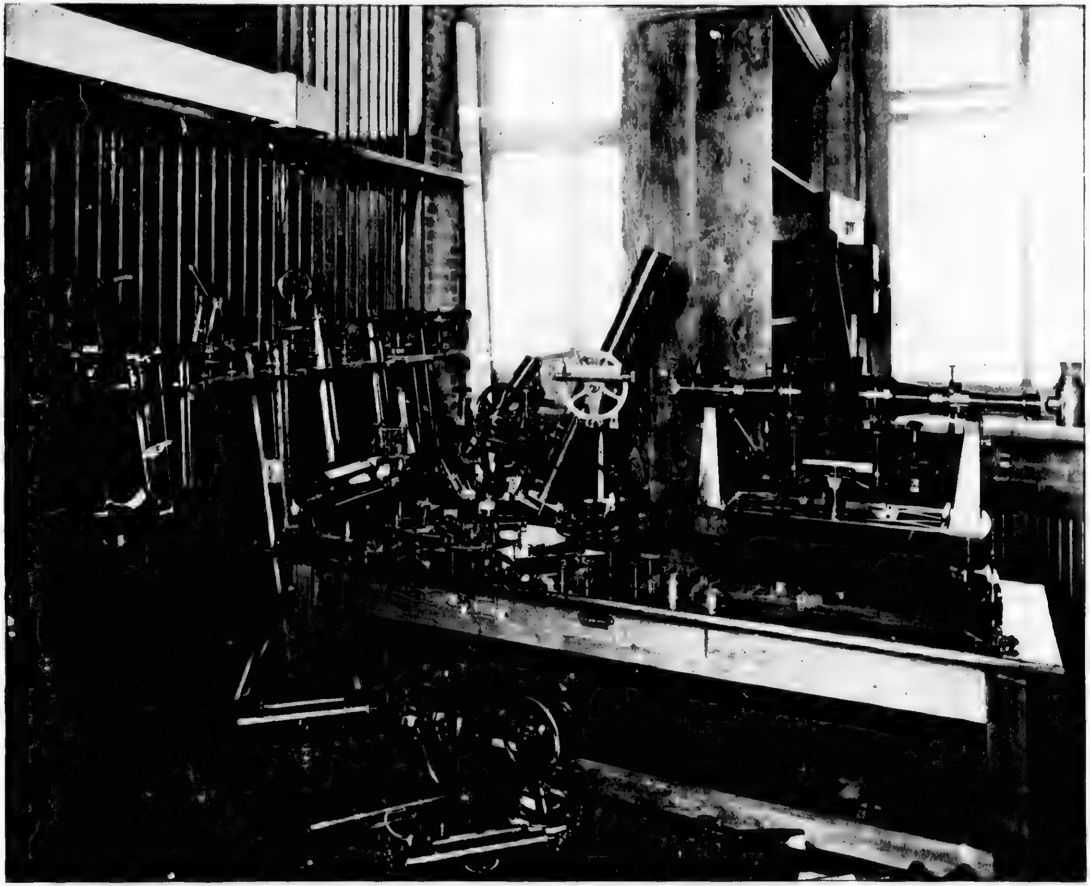
The practical uselessness for any immediate purpose of a given subject of study, may be no reason why it should not be pursued; but, on the other hand, the high immediate usefulness of a subject of study furnishes no ground from which an educator of loftiest aims and purest ideals should regard it with contempt or distrust. In either case, the question of real import is in what spirit the subject is pursued.

One of the most distinguished French writers of to-day on matters of education, Mr. Fouillée, writing too, strongly in advocacy not of physical but of social science, has frankly paid his tribute to the disinterestedness of spirit and the loftiness of motive which prompt and direct scientific research, even in its most practical applications. "Let us" he says "pass in review the great founders of modern science and the creators of industry, the Keplers and the Fultons, and we shall be struck by the idealistic and even utopian tendency peculiar to them. They are in their own way dreamers, artists, poets, controlled by experience."

And if, leaving abstract reasoning, we turn to contemplate the manner in which the several professions are practised in the community, I seem to find corroboration of the view that the study of science and its applications to the arts of life do not tend to produce sordid character, or to confine the man merely to material aims. Every profession has its black sheep and its doubtful practitioners; but, while frankly admitting that there are mercenary physicists and chemists for revenue only, I boldly challenge comparison between the scientific men of America, as a body, and its literary men or even its artists, in the respects of devotion to truth, of simple confidence in the right, of delight in good work for good work's sake, of indisposition to coin name and fame into money, of unwillingness to use one thing that is well done as a means of passing off upon the public three or four things that are ill done. I know the scientific men of America well, and I entertain a profound conviction that, in sincerity, simplicity, fidelity and generosity of character, in nobility of aims and earnestness of effort, in everything which should be comprised in the conception of disinterestedness, they are surpassed, if indeed they are approached, by no other body of men.

Let us then, cheer on every enterprise for the extension of scientific and technical education, without any misgivings as to its effects upon the character and subsequent life of the young men of America; without any fear that they will be rendered sordid in spirit or low in their aims by reason of the practical usefulness of the studies to which they are called to apply themselves. There is a wonderful virtue in the exact sciences to make their students loyal, just-minded, clear-headed, and strong against temptation. Here, no insidious tendencies to mere plausibility, sophistry and self-delusion beset the young and the ambitious. The only success here is to be right; the only failure possible is to be wrong. To be brilliant in error here, is only to make the fact of error more conspicuous and more ludicrous. Nothing but the truth, nothing less than the whole truth, this is the dominating spirit of the laboratory, which never withdraws its control over the student to keep him from the wrong path, which never intermits its inspiration as it urges him onward to the light.

*President Walker was prevented from being present by a snow blockade on the railway.



SURVEYING INSTRUMENTS

THE REV. G. GRANT, LL.D., F.R.S.C.

Principal of Queen's University.

"In the world there is nothing great but man, and in man there is nothing great but mind. This is an everlasting truth, which the children of light always affirm, and which the children of darkness always manage to deny or evade. Certainly, the children of darkness do not always take one form; they may appear as modern theologians and ecclesiastics, or as artists and men calling themselves men of culture; they may appear as philosophers and men of science, as well as in those cruder and more vulgar forms which the Germans summarily denominate as "Philistinism." But in all forms alike they are afraid of mind; and yet it is strange it should be so, because we have very ancient and also very sacred authority for the truth I have referred to. In the very first pages of holy writ we are told that man was made in the image of God; and even the most literal interpreter would be shocked if that was interpreted as meaning that the Supreme Being is a "body six feet high, weighing from 150 lbs. to 200 lbs. avoirdupois, and shaped like a forked radish fantastically carved." They all know that it is not its meaning, but that God is the Supreme Reason of the universe, and therefore man is like him only so far as he is rational. And yet, notwithstanding this high authority and the voice of God in their own souls, the welcome sometimes given, yea always given, to every new development of mental activity is an attitude more or less of suspicion and constraint. The most general attitude is like that taken by a very distinguished office-bearer, the treasurer, of the most distinguished little company that ever trod this earth, who, in reference to an act of love, nobleness and self-sacrifice, said, complainingly, why this waste? Would it not have been better spent by putting something into my pocket? And there are friends of mine, whom I know well,—I have some very queer friends—whose best attitude towards a building like this would be, why this waste? Would it not be better to sell it and spend the money solving such deeply interesting and valuable problems as how many angels can dance on the point of a needle? Others take the attitude, how much better to plant groves or build cloisters where, in "dim religious light," the dimmer, the better, we might be able to form men who would be recluses, scholars indeed, not men soiling their hands with the dirty work of machinery, but men like Browning's grammarian in all things, except his enthusiasm, who gave us the doctrine of the enclitic de. All this sectarianising of reason, all this killing of the light of reason, because it is thought best to cut it up and worship a bit instead of the whole! Against all this I hail the erection of these buildings as a proof that McGill is getting beyond the mediæval and eighteenth century conception of a university. A university is the storehouse and the organ of pure reason, and if it is not that, it is nothing. It must be that or worse than nothing to the mind that lives. Its aim is to interpret man and nature, and it cannot interpret either by taking a dualistic view of the universe. In interpreting man it is the duty of the university not to separate the student from the every day life of the world; its aim is to make the student a citizen, and to make the citizens students, to give them that love of science which must be in the heart of the man who is in all our hearts this day. And while it thus seeks to interpret man, to mediate between the man of thought and the man of action, it also seeks to interpret the world, because it knows that in every interpretation of the world it is doing as Kepler said when he discovered his laws, it is thinking the thoughts of God. It see the world, filled with all subtle and mighty forces ready to do man's bidding, and it is trying to spell them out in order that man may thereby have a physical basis for a lofty spiritual life. The world is full of these forces, and we boast of ourselves when we spell out one of them, instead of humbling ourselves because we have been so slow to spell it out. What are the great forces these buildings testify to? They tell of steam and of electricity. These are not new facts, they are as old as creation itself, and yet it was only last century we began to interpret the force of steam; and yet we brag about the great discoveries we make. I saw in the museum of the University of Glasgow the first rude model of a steam engine James Watt made, as it were, only yesterday. As to electricity, the Greeks knew it well, and yet it was only the other day we began to learn something of its laws and marvellous potency. Every day we are learning something new, and every day we believe we shall continue to be so if we only combine the earnestness and modesty which should characterize a student. Is nature exhausted because we have learned a little about electricity and steam? No, sir. We have only scratched the top of the soil of nature. One of your professors was telling you last night that compressed air was quite as good as electricity. I think we all have experienced what air is from the moment we first drew breath, and any man who has been in the North-West in a blizzard, or at sea in a cyclone, knows what compressed air is. But men never bethought them to use it in the bowels of the earth for mining, and gross, vulgar purposes of that kind. We are learning step by step, and boasting what God-like beings we are, instead of humbling ourselves in the dust because of our unwillingness to receive or interpret the good gifts of God. These are a few of the things which strike me as I see these buildings, and I come here, therefore, as a representative of sister universities in Canada to bid you a hearty God-speed in this work, and to say there is no city in Canada that ought to have a first-class school of mechanical and electrical engineering so much as the city that is the great port and the commercial metropolis of Canada. This can be historically vindicated. By the report of the retiring president of the Montreal Board of Trade, it appears that in 1809, John Molson, two years after Robert Fulton built a steamboat to sail the Hudson, built one to sail the St. Lawrence between Montreal and Quebec. I saw recently in an address by Sandford Fleming that the first boat that might

legitimately be called a steamboat was built in Quebec and came up to Montreal to be fitted with engines in 1833; and that was not only the first steamboat that ever crossed the Atlantic by steam alone, but it was the first man-of-war steamer too. Well, if in those days Montreal could build steamers and supply steam engines that crossed the Atlantic, is it not clear that it becomes Montreal to have an institution where men can be trained for the highest possible applications of steam, in order that we may do justice to our country and our young men. We believe our young men should be able to understand these things, although some people seem to fancy that it is beyond their powers. I am sorry to think it is only when we lose them we value them. The Provincial Secretary was talking about my being the head of a university in Nova Scotia. He never offered me any such position when I was there. You see what a humbug he is; but he is a politician. When he does make the offer I will do like the Premier of Ontario, take it into my most serious consideration. In this city, I say, we should have a school certainly equal to anything on the continent for civil, mechanical and electrical engineering; and I rejoice, and every university in Canada rejoices, in this fact, because what injures one university injures all, and what benefits one benefits all. There is no unworthy feeling in celestial minds, though there may be in minds terrestrial. Therefore I would conclude by saying, not only do we congratulate McGill on this, and hope that it may go on to greater things, but we congratulate it for the sake of the country as well as the city. Our country is new. It is not so old as the country to the south, which often speaks of itself as new, though Harvard has celebrated its 250th anniversary—McGill not more than its fiftieth. We are a new country compared to that to the south, and we need all our universities. Humanity needs them all. When we think how poor, suffering and blind humanity is; when we think that in every great city we have not only those miles of palaces, those lengthening streets and noble squares, those magnificent hospitals we all delight in, those abodes of ease and luxury and wealth, we are all so proud of, but also the humble homes where, it may be, men's lives are cut short because they have not had a fair chance to live, where men are bent double because they have had to do more than their share of hard work in life, where women it may be, are confined in the sweater's den, where children are starving because, although in a country where Manitoba "No. 1 Hard" sells for fifty cents a bushel, there is not enough bread for them to eat, we certainly must confess that poor humanity needs all the forces that will elevate dignity and sweeten its life.

THE REV. PRINCIPAL ADAMS, M.A., D.C.L.

of the University of Bishop's College, Lennoxville.

It is a great pleasure to join in sympathy with the hearty joy of a great intellectual body at a great celebration of this kind: representing as it does the noblest moral aspect of character enshrined in a great achievement and one which tells of the latest victories of mind over matter. Pure and unselfish and far-reaching beneficence has been exercised by one whose work in this regard classes him amongst the leading patriots in action of the Dominion, perhaps of the Empire. Mr. McDonald with his kindly heart and with an enchanter's wand has caused palaces of science to spring up here with almost the celerity of the fabled genii, and palaces of a more solid and lasting kind. To a representative of another university of the Province it is a peculiar pleasure to be present on such an occasion and to think that by the buildings and apparatus formally handed over this day, a great sister university has been promoted in these regards to the very first place on this Continent and probably therefore to the first place in the civilized world. In the school in which I have endeavored to learn my life lessons we are taught to rejoice in the success of our brethren as well as in our own. All real lovers of knowledge, and lovers of universities must feel true pleasure in the extension of the means for gaining and extending knowledge and in the healthy extension and growth of a university already great and useful and loyal. To speak of these buildings as leading the world is no idle boast. Only a few days ago as a Cambridge graduate I received a circular asking for aid in erecting an Engineering Laboratory and the maximum cost attempted by the ancient and famous university was no more than £23,000 for building and equipment, a much smaller sum than that expended on the Engineering Faculty of McGill by the princely generosity of one man. Further I do not think I can refrain from expressing personal congratulations to the head of the Engineering Faculty on this great crowning event of his faithful and arduous career, his creative career I might almost say, for under his headship this department has grown from a small seed to a very considerable tree. As an old college friend and as a Cambridge man of the same year, (twenty years ago we graduated together), it has been a great satisfaction to me to see the work of Prof. Bovey expand so solidly and so magnificently. To utilize the wealth so wisely bestowed we require wise administrators, wise teachers and exponents of the laws to be illustrated. Several of our friends of the Mathematical Tripos of 1873 are widely scattered and are doing good work. Nanson is Professor of Mathematics in Melbourne, Gurney in Sydney, Garnett is Principal of the Newcastle College of Science, Hicks of the Firth College, Sheffield. I do not think Professor Bovey would exchange his sphere of work for that of any of our compeers. Nor is any one of us of that standing in a position where we can do better educational work than he can do here. Leaving personal considerations which, however interesting, are after all partial, and considering the general bearing of such an increase of educational appliances as we celebrate to-day, we note that there need not be and ought not to be any rivalry or friction between Literary and Scientific education. Ancient and modern are not enemies; the true modern is a true child of the true ancient. As the stream of time went on, the human race was not idle. Now and then a great mind grasped a

wider truth, and so greater width and greater depth came to the stream of knowledge. A Hebrew psalmist reaching out into the Infinite in immortal words expressed the deepest yearnings of an immortal spirit, as it tried its wings on the empyrean and found that faith would bear it. A Greek minstrel singing in immortal melody the activities, the sorrows, the enterprise, the wars and loves of an early Grecian people, gives us a picture of life never in some respects surpassed. What shall we say of Pythagoras, of Kepler and of Archimedes, of Shakespeare, of Milton, of Newton? Each in his own way and starting from the platform on which he found himself, made a marked progress and discovered some steps in the road towards the same – the discovery – the unfolding of truth. And if the humanity is the child of God, truth is God's voice. In that voice there are many languages, many harmonies and none of these will be found to be contradictory at the last. Nor need the votaries of the various temples of truth rail at each other or deride each other. In studying literature, form is found to be beautiful, but form is not all; a beautiful form in worthless matter is to be deprecated, and good material is always worthy to be shown forth in a noble form. Do not undervalue the study of Language nor the study of Literature, nor let the students of languages think that a study of words is sufficient. Every class of student can learn something from every other class. Nor can any one claim that his study is the only essential one. All study must first be literary, for language is the symbol of thought; the more practical education is as well, the better, but the practical is meant to subserve and illustrate the thought. The stupendous result of science whereby the human voice speaking in New York can be heard in Chicago, is wonderful, but if the speech that is so conveyed be worthless or misleading, how much is the human race the better for that great achievement: to be rapidly conveyed by sea or land is a great triumph of engineering, to cross the ocean scatheless in a storm, to cut in twain the obstinate isthmus, to bridge the broad torrent, to bore the tunnel under the broad Severn, or the broader Channel, these are great triumphs; but what if those who are conveyed remain commonplace and sordid? It is that such may not be the case that your benefactors endow you, that your professors instruct you, that your ministers of religion strive to help you. Let us learn not only the intensity of the forces of nature, illustrated through material; let us learn also the laws, subtle and unerring, that are the customs of Nature, the growth of the wondrous garment of God; let us learn too to be reverent, to be simple hearted, sincere, faithful seekers of truth; let us remember too, whether teachers or taught, in this day of great rejoicing, that every gift, whether spiritual, mental or material, with which we are collectively or individually endowed, carries with it an increase of responsibility.

Success to the new buildings and to the Applied Science Faculty!

DR. HOWE,

President of the American Institute of Mining-Engineers.

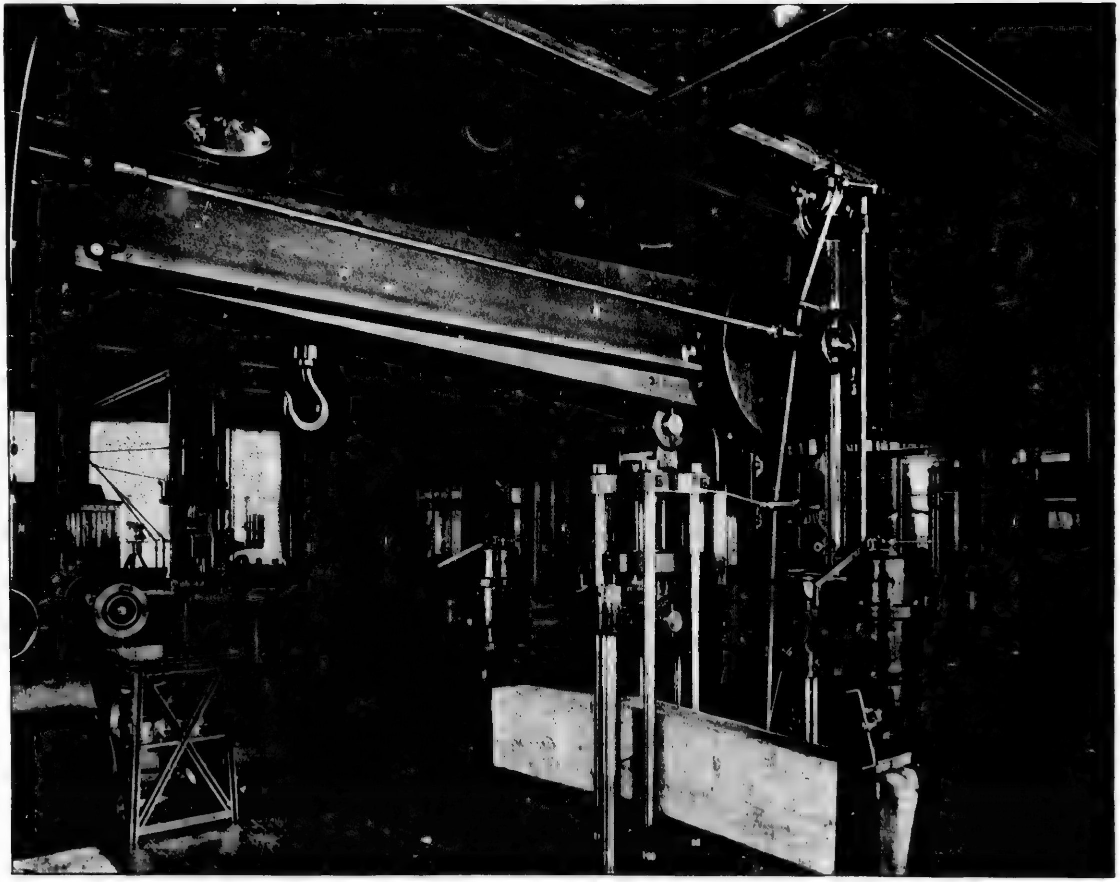
Not only as President of the American Institute of Mining Engineers, but as being identified in some measure with the sister institution of learning, the Massachusetts Institute of Technology, I want to congratulate you most heartily, and that without reserve, on the completion of this noble work. One hardly knows whether to admire more the princely gift or the skill and wisdom we see displayed about us everywhere. But more than these princely gifts I wish to congratulate McGill and the city of Montreal on having among you the princely heart that prompted this gift. In these days of grasping for wealth our only dread is lest our wealth should work us ill, instead of well. We might travel far and long without finding so potent a charm to dispel that dread as the event we are here to-day to celebrate.

PROFESSOR THURSTON, A. M., LL. D., Doc. Eng.,

Director of Sibley College, Cornell University.

It was with peculiar pleasure that I received and accepted the invitation extended me, a few days ago, to attend, on this, which I regarded as a [illegible] and important occasion. Since the days of Archimedes and Euclid, the milestones marking the progress of nations have been, [illegible] otherwise, the foundation of schools; and we may well make our base-mark and earliest point of reference the Alexandrian foundation [illegible] about two thousand years ago.

The [illegible] school, the first real "university" that the world ever saw, and I am not sure that it has not been the only one in the true sense of that term, was the first, if not the last to dare to offer to its students all the then known branches of literature, of science and of art. We [illegible] university which really presents to its students all the literatures, all the sciences, all the arts of our own times, far less all that history [illegible] has to offer. The drift of learning towards the West, in the days of Saracen domination and the establishment of the [illegible] of Moorish Spain and those of the whole period of the middle ages in Europe, even, in fact, up to the present time, produced a [illegible] inadequate education of youth and age alike. The universities, so called, of those times were, for centuries, mere schools of literature and [illegible] sciences. They were the schools of the [illegible], teaching what could be taught by the monk in his cell, learned by the



WICKSTEED TESTING MACHINE.

pupil from oral instruction, developed by the operation of the logical and speculative faculties, without aid or stimulus from nature or art. Learning was restricted to those departments of scholarship which the recluse could readily enter upon and easily acquire; the studies of literature, of history, and of theology and its related subjects. Greek and Roman literatures were preserved and made much of; ancient and, for the time, modern history was given untiring labor in its preservation, completion and arrangement; rhetoric, logic, and speculative philosophy were made the cornerstones of the edifices of learning. But Greek art and Greek sciences, in the domain of nature, were forgotten, and Roman construction, and the applied sciences embodied in their work, fell out of sight.

I think this, probably, the reason, in large degree, of the prolonged period of stagnation, the "dark ages," of the centuries intermediate between the days of the older and those of the modern civilization. Progress in the sciences and the arts was the necessary basis of all onward movement, whether in the useful or in the fine arts, whether in morals, manners, or literature. The teaching of youth, in those days, the learning of the period, the civilization of all those centuries, had become fossilized, and the world was checked in its forward sweep by the impeding friction of a retarding conservation.

With the revival of a learning of the progressive sort, the awakening of science, and the introduction of scientific method, the whole world arose to a new life; and, about the middle of the fifteenth century, began not only the modern period of active, earnest, powerful movement, in every realm of thought, but, that fruitful activity of research which has made the conscious, systematic, pursuit of new and concrete fact and knowledge, the distinguishing characteristic of our own time and of our own civilization. With this revival of the activity of the brain of the race, came new and better ideas of the proper method of cultivation of the faculties and of inspiration of the soul, of building the brain and of reconstructing the schools; and the Marquis of Worcester, Milton, Vaucanson, and their many successors, began to study the best form of a "complete and perfect education." We are all familiar with the marvellous growth of this recent phase of the philosophy of education, and with its singular and imposing results, as developed first in France, then in Germany, and in Great Britain. The progress of the world on this side the Atlantic has been less well-known. It may be of interest to say a word of the movement—we look back but a generation or two at most—in the United States.

The history of this work is substantially as follows:

Some thirty years ago, and especially, after the great international exhibitions of France and England had disclosed the progress made in educational matters by continental European nations a general sentiment arose among the more thoughtful citizens of the United States that their country was far behind foreign nations in the development of modern systems of, especially, technical education; while it was felt that this country, if any on the globe, needed, and could profit by, such systems. This view came to be shared by the more statesmanlike of our legislators, and the result was the attempt on the part of a number of members of the Congress of the United States to initiate a general movement in this direction, begun and directed by the General Government, and set in operation and carried on by the several States, each in its own way. At this time, though a nation of mechanics and agriculturalists, the Rensselaer Polytechnic Institute, a school of Civil Engineering, was the only well-known technical school in the country. Agriculture and the Mechanic Arts, Engineering in all its departments, were either entirely unrepresented in our systems of technical instruction or were most inadequately supplied with facilities for the acquisition of the scientific foundation of such arts. Engineering, recognized as a profession, from a very early period, abroad, was in this country so little understood and appreciated as to be confounded, often, with the trade of the surveyor; and its more recently organized branches, mechanical engineering and others, were totally unrecognized. The people were not only substantially destitute of all facilities for the education of their sons in technical departments, but were even unaware, generally, of the existence of either such constructive professions or of the systems of professional training at the time well developed and in extensive operation in Europe.

The consequence of this state of affairs was that the technical schools of France, dating back to the days of Vaucanson, and the even more systematic and complete organization of the German States, sustained as they were by their governments on a most liberal scale, were giving enormous advantages to those countries; and even Great Britain was beginning to suffer from the successful competition induced by this scientific development of the technical departments of education and their application of the most advanced sciences, and of the most perfect art, to every department of industry. It was this state of affairs which led that great engineer and famous naval architect, John Scott Russell, when presenting his treatise on "Systematic Technical Education" to the Queen of England, to plead in his dedication, for the "uneducated English folk," then suffering from business depression, through having been neglected and allowed to fall behind other nations, better cared for, by the men whose duty it was to lead as well as govern the people."

Russell opens this remarkable book with the following impressive statements, no less worthy of attention in these later years and in these States of the Western Continent:

"Twenty years ago"—this is written in 1869—"professional duty took me to Germany for the first time. I cannot forget my first impression at the sight of whole nations growing up in the full enjoyment of systematic—organized—I might almost say perfect education. I had already

become acquainted with some theories and forms of education. I had read Plato's description of the perfect training for a nation. I was familiar with education in England, in Scotland and in France; I was familiar with elementary school teaching, and had enjoyed the privilege of university education, and the still higher education of the workshop. I was familiar with the system of Bell and Lankter, having had personal acquaintance with its authors, and I had myself taken an active part in schools of art and of mechanics institutions; but I confess myself to have been profoundly astonished, I may say humiliated, at the sight of nations whose rulers had chosen to undertake the systematic education of their people, and of people who had chosen to bear the burdens and to make the sacrifices necessary to obtain it. I do not know to what class of men in Germany the forethought, organization, and patriotism are to be attributed which made them lay aside personal ambition, political animosity, religious sectarianism and State parsimony, in order to unite all classes of people in the unanimous effort to raise every rank of society to a higher condition of personal excellence and usefulness, and, by diffusing equality of education, to extinguish one of the most grievous of class distinctions."

Coming to the conclusion that the *Technical University* is the end of education for the youth, and that it commences the work of the man, "as inevitably the end of education for modern life as the learned university for the three ancient professions," the great Engineer goes on to say: "It can surprise none of us that a technical training has been thought as necessary for the new professions as for the old. The wonder will be how the English nation could have so long remained comfortable under the knowledge that, out of the dozen professions for which the whole of her youth were destined, there were only three for which it was thought necessary to provide methodized means of instruction. It is much to the credit of the German character that a nation to whom we have always accorded high praise for their theoretical learning and abstract philosophy should have outstripped us by a whole generation or more, in foresight and farsight; and should have taken measures to promote the application of all the discoveries of abstract sciences to the speediest, wisest, and most economical solution of the practical problems of daily life and business." What Russell here says of the systems in vogue and their defects, as observed in his own country, might have been said, in fact may be said still, and with even greater force, in the United States. We were then almost absolutely without even the beginning of such an education as has built up Germany and made France famous; we have little more than the beginnings to-day. France is still the exemplar in the formation of the scientific system of education; Germany still leads both in the completeness of her system as one of national extent, and in the thoroughness with which its details have been worked out and applied to the advantage of not simply the nation, but of cities, of towns, of villages, and of every vocation among the skilled industries, as well as of the professions. Great Britain can boast her South Kensington Museum, and its Science and Art Department and its ramifications, and the United States can boast of here and there a peculiarly practical and successful technical school, college, or even one or two Universities, illustrating, somewhat sporadically, useful phases of the modern developments of educational methods. What has been here done, however, is due, in part, to a few private foundations, in part to the system known familiarly as the "Land Grant Scheme," sustained by the General Government and the several States, acting in more or less imperfect accordance with the provisions of the legislation initiated at Washington in 1862, by the so-called Morrill Bill, and, also, in some instances, by the independent action of State governments, founding State Universities, either in advance of or in connection with their legislation promoting the Morrill plan. The United States can perhaps exhibit the beginning of a more extensive system of technical education than Great Britain; but much remains to be done in both countries before it can fairly be said that the perfection of the systems so long in operation on the continent of Europe is even remotely approximated.

The question recognized by Senator Morrill and his colleagues in 1862, as present and as constantly increasing in importance, in the United States, as well as in Great Britain, was that which had been so early enunciated by the author of the work to which reference has been already made: "Do you choose, among educated nations to remain an educated nation? Or will you consent that the education of the rising generation shall be as good as that of any other educated people? Will you at once organize the ways and means of doing it?

They by that time saw clearly that, besides that phase of education which, alone had been fully recognized, that "general education" which matures the man and gives him simply culture and intellectual power, there must be offered another sort—the education demanded by the citizen unable to give time or money to culture and purely intellectual training, and which has for its purpose the fitting of the man for "that narrow round of duties which the sub-division of labor in civilized communities imposes on the individual as his special contribution to the common-wealth, and which may be called special or technical." It was to provide this hitherto unrecognized system that the Morrill Act and later legislation of similar character, in the National Congress of the United States and in the several state legislatures, have been given form.

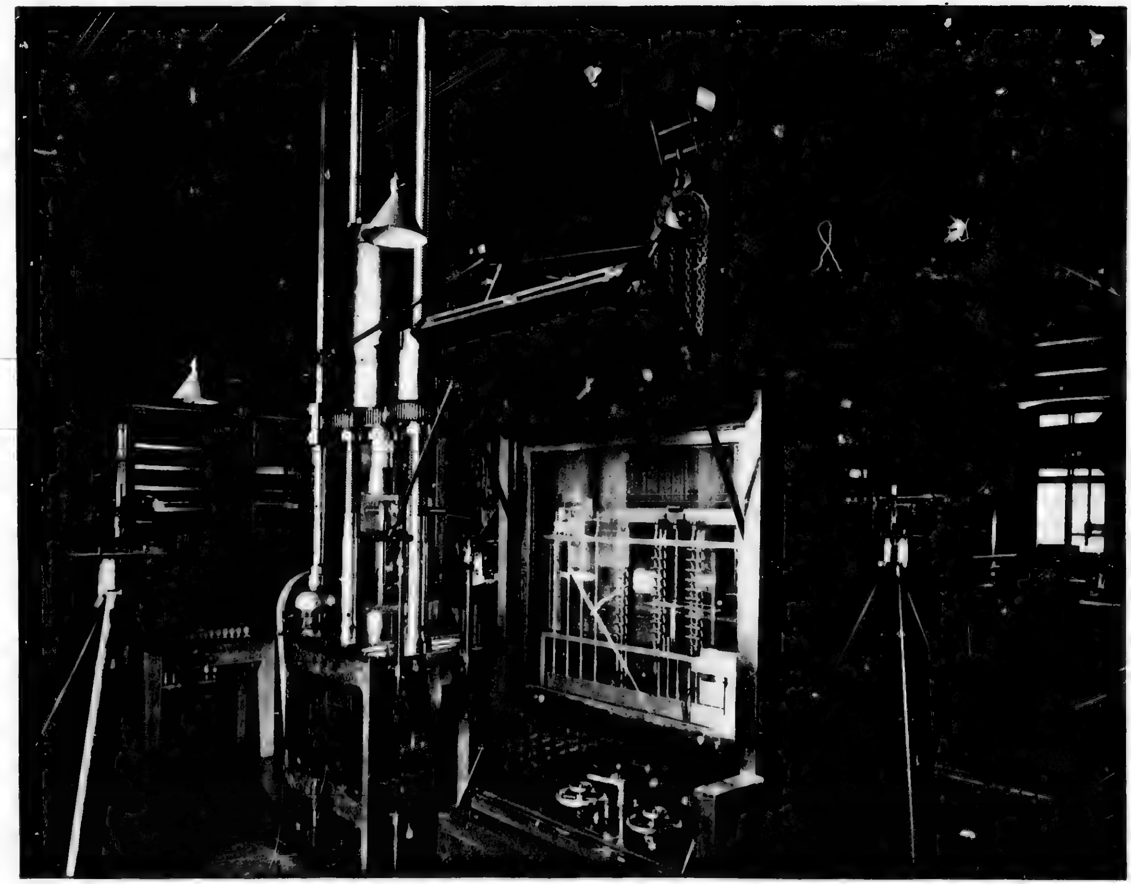
This system of modern education of the people for the people's work, of the citizen for a citizen's highest civil duties, properly organized and administered, provides a series of schools in ascending grades, so planned and adapted, one to another and to the final purpose of all, that the child may be sent to the primary division of the series at the earliest desirable age, and can be steadily passed onward and upward, from school to school, from class to class, until he has passed from the preparatory, into and through the trade-school, and, if time and means permit, and if his tastes and talent fit him to do so, even through the higher schools of applied science and of engineering. In such a system, "rich and poor may

rec[illegible] the same elements of the same education, alike; the difference consists in the length of the period during which the student or his parents can afford that he should live without earning his living; and in special cases that is no obstacle, for the man who shows distinguished ability or special aptitude is reckoned an honour and a gain to the community; to let him stop short is reckoned a public calamity, and, without coming under the burden of obligation or bending to the humiliation of charity, the distinguished son of a poor man continues his education at public cost." Such a scheme should be so arranged that the pupil leaving at 12 or 16 may have at least his first steps in education made complete up to that point, and of maximum value for the practical purposes of his daily life. The highest grades should obviously be so adjusted as to give the professional training between 17 and 21; so that the young man may enter upon the practice of his profession, and independently, on attaining his majority, relieving his parents of the cost of his support.

Substantially the same general instruction would be given in such a scheme to all classes up to the age of perhaps 16; and this would include the elementary mathematics, physical science, art, languages, and history, to such extent as may be found practicable. From this age on, the various schools may offer differing schedules of instruction, and differing lines of preparation for as different branches of ultimate application. It is here that the trade schools must usually come in; and this period must be that of special preparation of those who propose going up higher, for the technical schools, on the one side, and for the schools of culture on the other. "Manual Training Schools," independently, or in connection with the standard high schools; trade-schools, as of weaving, of carpentry, of machine construction, of masonry; the higher grades of schools of science, and those of general education preparatory to college work, including the classical schools, take their place here. Above these, on the higher plane, stand the classical and general educational colleges, for the one division of students, and the professional and technical colleges for the other. But it will undoubtedly often happen—it would be better always so—that the intending practitioner will pass through the liberal branch before taking up the professional study of the other side; securing a liberal and broad culture as well as professional training. This is already done, in many instances, in the United States; and this method of education will undoubtedly become more general as time goes on and the number of young people desiring it, and finding it possible, increases with the growth of the country in intelligence and wealth. But the country must, in time, in approximating the highest and best system of education of the people, possess both technical and liberal colleges, and technical and liberal universities as well. These highest institutions of learning constitute the apex of a pyramid of which the body and foundations are composed of the preparatory and high-schools of the States and of the whole lower primary school system, and of the home-training which lies beneath and supports all. It is such a system as this which Germany and especially Prussia, has built up during this past century, with such marvellous results, in the promotion of the material as well as of the intellectual development of the Nation, and, as stated by Henry Barnard, in "creating and diffusing a patriotic spirit among the people."

In the United States, thanks to the wisdom and patriotism of Senator Morrill and his colleagues and coadjutors, a beginning has been made in which we take some pride and for the future of which we have great hopes. It is but a beginning; but it is one which has already reached a point at which we may regard it with confidence of steady and unlimited development, a future such as Scott Russell would have been delighted to contemplate. Every State of the Union west of the Alleghanies, with hardly an exception, has a State university, constituting the apex of its educational pyramid, and aiding and directing and promoting the symmetrical and productive development of the whole system of the State from primary school to university; and all States of the Union have their colleges—either as parts of the State University, or as independent—devoted, under the terms of the Law of Congress, to the promotion of "the liberal and practical education of the Industrial Classes," in all the pursuits and professions of life" into which they naturally pass from the schools. This work is founded mainly upon the provision of the "Land Grant Bill" giving, in 1862, 30,000 acres of the public lands of the Nation to each district sending a senator or a representative to the national Congress. But this is by no means all that has been done for the completing and perfecting of the education of the people. The several States have, in most cases, given liberally to the same cause and have added to the donations of the general government their own contributions. In some instances, they have shown extraordinary liberality and have devoted a special State tax—of from one twentieth to one mill on each hundred dollars, to the permanent support of these grand enterprises. Naturally the State University has become at once the pride and the noblest blessing of the State. Cornell, the New York State University, although less well supported than the universities of many other States, has been so well sustained by private liberality, on the part of Ezra Cornell, Henry W. Sage, John McGraw, Hiram Sibley, and its own first President, Andrew D. White and others, that it to-day expends an income of a half million dollars in the education of 1700 students, and can find profitable use for an income of double that amount in the extension of its great mission. The other states expend, as a rule, smaller incomes on smaller student bodies; but all are growing in extent and usefulness and promise to become the greatest influence for good in the future growth in intelligence and wealth of the Nation.

But the plans of educators in the United States extend further even than this. One hundred and eighteen years ago, Oct. 1775, Samuel Blodget, the economist, addressed to General Washington, then encamped at Cambridge, the seat of Harvard University, the remark: I hope that, after our war, we shall erect a noble "National University" at which the youth of all the world may be proud to receive instruction." The answer



TESTING LABORATORY.

was "Sir: you are a prophet, inspired to speak what I am confident will one day be realized." This grand project of a crowning edifice in the system of instruction of a nation has never been lost sight of; although it still remains to be erected. Washington endeavoured to give the plan form and movement by contributing of his own means, and every President of the United States, from that day to this, has endorsed this, or some approximate method, of completing our educational system. A bill now lies before the National Congress having this purpose as its motive. A special committee of the U. S. Senate has the project in charge and many of the greatest educators and ablest men in our country are giving countenance and active assistance in its promotion. Such is the state of this greatest of enterprises on our side of the border. Education of all the people, for the good of all the people, will yet be the foundation-stone of the prosperity of the great nation which is here taking form. What grand future may not be hoped for by such a nation!

I should, perhaps, apologize for taking so much of your time in telling what has been done, and what is being done, on the other side of that invisible and intangible line which marks off our home from yours; which divides two peoples having so much in common, so little of difference; which, in fact, divides one great race into two hardly separate parts. But I have thought that perhaps this might be the very purpose of our coming—to tell what is being done elsewhere, as well as to see, and to congratulate you upon, the noble work here inaugurated, and to share your pleasure in seeing the work so far completed. Each country has cause for congratulation and both must move onward in this path, and rapidly, if they would early attain that future of prosperity and peace which every patriot and good citizen desires for his own country and for the country of his neighbors and friends.

Your great and growing Dominion is making here a splendid beginning of a most glorious work, and we who come from afar are surprised at its magnitude and delighted with the thorough British pluck, and the absolute soundness of plan and view, which the latest and finest of modern contributions to the great cause illustrates We take it to be certain that this is to become one of the elements of that larger and grander system of promotion of the best interests of the people of our whole continent of which the part which is being constructed on our side of the intangible line is also but another division. Let us strike hands in this grand project of the erection of a continental system of promotion of literatures, sciences and the arts, of all the learning that any of our people may or ought to aspire to attain, and make it the joint work of the Saxon race and our allies, throughout the American continent. With men of wealth contributing of their means, the State giving firm and steady support, men of learning giving their lives to the work; large brain and ample capital combining to make the work thorough and never-halting, what a future is assured to our common race!

On the continent of Europe, for every dollar expended in the education of the people, twenty are thrown into the deep sea of standing armies; in Spain, the proportions are said to be about one to sixty; even France, the most liberal of the continental peoples, pays out seven francs for the army for every one spent on her schools, and, on this side the ocean, the United States Government and people pay, directly and indirectly, more than one dollar per capita for war preparations, and but two dollars for education. Let us hope that the European proportion will soon be inverted, and that armies will be turned into the ranks of teachers, and that education will yet be more liberally provided for than war. With established systems of international arbitration, and with international laws administered by international courts, it should be perfectly possible and practicable. It is a discredit to civilization that this is not the fact to-day, that it was not, long ago, the method of settlement of difference among nations. Given the abolition of standing armies, at once the disgrace and the most terrible burden of the world, we should no longer find education a tax upon the resources, and noble buildings like these, grand equipments such as we see here begun, and the still more essential and necessarily large corps of teachers never yet nearly numerous enough to do the best work in the best way, might be made all that could be desired, and without other result, as a matter of finance, than comes of wise investment in private business; for education constitutes the best and most profitable of all possible investments for a nation. Increase your army of teachers, in the preparatory schools by one half; double your corps in the colleges and give the technical and professional schools three times the present number of instructors, and those the ablest in their respective professions whatever it may cost, and you will have no larger army of educators than will prove profitable, and the extra cost may be saved, with large profit, in your annual budget, by the abolition of the panoplies of war and the organization of international courts. On the continent of Europe, this means first conquering international prejudices and jealousies, but statesmen, wise and strong, and earnest, will yet come forward to accomplish this greatest of the tasks of the modern world, and Europe will yet be seen to transfer her expenditures from the account of war to that of education. This may not occur in our time; but it will surely come. On the North American Continent we are already brothers in blood and friends by choice; we have no reasons for antipathies, prejudices or jealousies; we are one in all but political form. Here, of all places on the globe, is the place for this latest phase of enlightenment to be developed. I have tried to show you that we are developing rapidly in this direction, over the border, and we have all come here to-day, to see your progress in the same direction. Our countries must strike hands to bring about this glorious result. In this we may unite without regard to political, largely

imaginary, lines, which hardly divide us in fact, which do not at all divide us in spirit. We can see, to-day, that we are here united. May our common advancement be as rapid, as healthful, as rich in fruition, during the coming years, as this splendid movement, which we here and to-day celebrate, gives us such good reasons to hope for! May this be a step in the onward flow of good work and good will throughout a continent; and may the beneficent flood continue to rise and to spread, until both continents, our present home and the homes of our common ancestors, shall enter upon that future of millennial peace which will surely come when education shall have vanquished armies! Here and now we see the source of a rising stream which contributes its current to the greater and lesser streams on both sides that line which cannot divide these two great and friendly nations, these nations of brothers, and which shall never cease to add its proportion to that flood which shall yet cover the world, and bring with it riper and richer harvests than ever Father Nile gave to ancient Egypt. Of all the good thus to come to an awakening world, this noble Institution of learning will do its full share through the means which are here so liberally provided. We may all unite in the hope that the great heart and philantropic soul to whom we all owe so much may long live to see the rising of that flood, and to witness the blessings which he thus contributes to the coming generations of that universal brotherhood of peoples which will ere long, so splendidly profit by this noble work!

COLEMAN SELLARS, E.D.,

Professor of Engineering Practice, Stevens Institute, Hoboken.

Finding at the last moment that it is impossible for me to be in Montreal at the time of the opening of the new buildings for the Science department of McGill University, I hasten to express my regret and disappointment at being unable to fulfil my promise to attend the ceremonies.

Having followed a course of lifework that made the acquisition of scientific knowledge of primary importance, I can fully appreciate the advantages that are now offered through such schools as the one inaugurated in the city of Montreal. Fortunately for this Institution, those interested do not have to go very far to find similiar schools in active operation, and to quickly appreciate the importance of the instruction they are giving as shown by the readiness with which the graduates of such schools in the United States of America obtain profitable employment.

On the contrary, in reference to a course of instruction such as heretofore has been given by the great colleges in the department of Arts only, I am reminded of a remaak made to me by my friend, Mr. George W. Childs of Philadelphia, who in speaking of the difficulty he found in obtaining educated, skilled help, said that "whenever he had occasion to call for an assistant in the literary part of the work on the 'ledger,' or in the office, from the clerks who receive advertisements at the desks up through all the departments of the paper, there were thousands of applicants, many of them being those who had earned high honor at some of the leading colleges of this and other countries, and such men out of employment, where ready to receive less than is earned by many laboring men in the United States, while, on the other hand, when it was necessary to fill a responsible position in any department requiring manual skill or technical knowledge, the applicants were few, if any answered the call."

Having just returned from a trip through some of the great industrial establishments of New England, I may mention that in one building alone, where probably 160 draughtsmen were employed on the one kind of work, I noticed that the distinctly native type was in the minority, as compared with the foreign element, while those men who are rising rapidly to distinction as experts in the same establishment, were young men, many of them comparatively fresh from Stevens, from Cornell, from Boston, from the University of Pennsylvania and elsewhere, all capable of filling their places solely by reason of their having been trained by the teachers in technical schools.

On the first April, 1843, I left school to begin work. Half a century has since then gone by and during that time my thoughts have been earnestly directed towards the subject of the education best suited to the present time.

While the new buildings of the University of Pennsylvania were opened in West Philadelphia, I was unexpectedly called upon to say a few words, and at that time, I bore testimony to the importance of a technical education directed towards the wants of those who are to follow a life in which the physical sciences bear an important part. No one felt more keenly than I did, or do now feel, the lack of the education that may be obtained through the ordinary course of a college education as belonging to the department of the Arts only. I could only speak from my own standpoint as a shop bred engineer and felt the weakness that results from a lack of early educational advantages, and never more so than when one has occasion to express ideas by writing or by word of mouth.

A technical education requires an accompanying knowledge of what is considered necessary in the broadest sense of the term "liberal education," but unfortunately the time at the disposal of most men who have to fight the battle of life unaided, is too short to acquire their scientific knowledge after they have passed through the regular course of a college education, separate and distinct from what is now known as the scientific course.

Before leaving school at the age of sixteen, for lack of parential advice, I had to carefully consider what would be needed in after life. It would have been impossible to have prepared myself for college and at the same time to have condensed into the short period at my disposal at school what seemed to be of more use than Greek could ever be. I therefore omitted that dead language and dropped Latin as soon as I could,

working harder to gain knowledge of living languages, that I might give some little time to what is now taught in the technical schools, but which at that time had to be picked up outside of the course directed mainly towards commercial life or preparation for college. In 1843 there was no such thing as a scientific college, nor did any exist until my own sons were ready to take advantage thereof.

By careful observation I have satisfied myself that the habit of thought of a student can be as well taught by systematic training in the natural sciences and mathematics properly handled as in many years devoted to the ordinary college course. The mind, too, is prepared to observe the minute differences that enable the engineer to discriminate properly in his understanding of the work which he has before him. That the ordinary college course separate and distinct from what is known as the scientific course does not properly train the mind, may be seen from the fact that whenever any so-called startling discovery in science is presented to the public, no matter how illogical it may be, if it be presented with any degree of plausibility, with the patter of the charlatan, it will be at once accepted by those who have had the highest education, fitting them to be lawyers or physicians or doctors of divinity. The humanities as taught in the colleges do not fit men to observe what is going on about them in lines outside of the books, they have read.

It was not many years after I had finished my schooling, that when called upon to speak at a public meeting I selected as the subject of my discourse the possible fallacies in science, using Payne's water-gas, then at the height of its fame, as an illustration of a pseudo-scientific problem which had been accepted by the men of seemingly broadest education, throughout the country, and yet which showed upon its face nothing but fraud when analyzed by a mind trained to separate truth from falsity.

Conservation of energy and correlation of forces were terms to be found in the dictionary and were probably used in the University of the day, but to most people they were, and still are words of little or no meaning, yet they express what should be taught in the primary schools of the country and not left to be imparted through the scientific course only. Every child should be made to know that in the universe there are bounds and limits to energy. The forces that are to serve man are never to exceed their natural bounds, we can only prevent waste.

Wealthy men have given their money to found Institutions of learning. Those who can afford to do so, are paying for the liberal education of their sons. This education is sought for on account of the good it is expected to do to the recipient of the education.

To the young man who has selected for his course of life, law or medicine or theology, there have been, for hundreds of years, colleges offering him what he requires, in a measure, for his peculiar lifework, but it is only through the scientific schools and the technical schools, as they are gradually becoming improved, that the kind of mental food is offered that will make men ready to take up their work as scientists when they are to earn their livings as mechanics of a higher grade than the mere workman.

The function of any school is to teach men how to think, and those pursuing that line of thought that runs in the rut worn by the vehicles of long ago, have difficulty in getting out of this rut and finding the path across the plain that is not yet marked clearly by well defined roads and lines of progress. The habit of thought that will be of the most use to the men who are to be the greatest engineers of the future must be as catholic as it is possible to make such education. It must be in the direction of giving them that kind of instruction that we have been obliged to seek for ourselves with so much labor and so little outside help.

We are in an experimental age, we are in an age of startling discoveries, and we are called upon to exercise mental functions that have not been trained through the centuries, which have not come to us by inheritance, but have sprung upon us during the lifetime of the locomotive. Happy is the man who in spite of these difficulties has the inheritance, of a line of mechanics for ancestors, and yet it is in the power of those who have not this advantage of heredity to acquire that thorough scientific training which will best enable them to think and act judiciously, no matter what position they may occupy in life.

There are those who claim that wisdom and knowledge can come from experience only. The wisest are not always the most experienced or those who retain the most in their memories. Experience in science may not be wisdom. Wisdom must extend beyond the organ of the senses and be associated with reason. The one best able to display wisdom must possess a store of experience, arranged mentally in such order as to be found most quickly when needed, by constant exercise of the mental faculty, ready for analysis and comparison. Such men can reason distinctly, reaching backwards towards the cause and forward towards the effect, whether in art, in mechanics, in law or in statemanship.

We are living in an experimental age, and modern civilization is possible only by reason of what has been accomplished in administering to the wants of man through the advance in science. No education is complete without the habit of thought that will enable one to separate truth from falsity. We meet continually men of great learning who are in some respects children in innocent confidence in humanity, listening in confidence to the plausible schemes of adventurers with no power of mental self-protection. I see in my mind's eye now a dear, good and wonderfully learned man, who from a single bone could in an instant build up the living form from the small remnant of what was once a living, moving, sentient animal, but who could see no deception in an exhibition of mechanical motion presented by a charlatan coupled with the pseudo-scientific jargon.

The education needed for the nineteenth century is the education in the path of human progress with all else from the past that the time at command will enable the student to assimilate [illegible]!

The opening of every new scientific school is a step in advance and brings to me a feeling of satisfaction. The institution that fails to give to the public what is wanted will drop back in the race. The scientific training that comes nearest to making its alumni ready to do good work will take the lead in popularity.

Its managers must, however, find out what is wanted and try to fill that want. They must not permit their graduates to find that they have to give up habits of thought and methods learned in school to take up what they are expected to do when seeking employment. It will be too late to find out what is wanted from the alumni of any new school. It is better to keep in touch with the working world all the time and to draw to the rank of teachers those who have had a wide experience in practice.

Could I have been present and able to speak, I should have given no advice, but would have praised the efforts of those who have made the McGill school a possibility, and would have spoken words of encouragement to its Trustees and Faculty.

Deeply do I regret my inability to do so now, and my best wishes are for the success of the Scientific Department of the University.

MR. E. P. HANNAFORD,

President of the Canadian Society of Civil Engineers.

As president of the Canadian Society of Civil Engineers, and as a President but lately appointed to office, and therefore not fully matured, allow me to say in regard to some of the remarks which fell from Dr. Raymond, and in his reference particularly to Ireland, I don't care about Ireland, because I think it will take care of itself; but I do care something, and a great deal about our profession and about the engineers of this continent, in particular. The late Mr. Thomas Workman and our good friend Mr. McDonald have been kind enough, by their bounty, to give you a building here which will turn out any quantity of engineers, and I do confess that the responsibility on the people of Montreal and of Canada generally, as to what will become of your young engineers, is very great. Although you are at present in a corner of the room, you will very soon have to come out of that corner, and will have to make yourselves felt in this or some other country. Therefore, I say to the people of Canada that the employment of engineers should be more general than is the case at present. The engineer can do duty, and good serviceable duty, to mankind generally and to people in particular, by saving money and lives. Men of standing in our professon are listened to, but as to what will become of the graduates is a very serious question, and yet there are hundreds and hundreds of positions which these young men can fill, and fill with credit. But I am sorry to say a great many of them are not yet employed. We must learn to overcome this difficulty. We can do it, and can do good to our neighbours and ourselves by giving employment to [illegible] young men that are trained at McGill, and this, Your Excellency, ladies and gentlemen, is one of the duties we shall have to see to in the future, so that we may supplement the goodness and kindness of Mr. Workman and Mr. McDonald by caring for the graduates turned out from this and other similar institutions.

MR. JOHN BIRKINBINE,

President of the American Institute of Mining Engineers.

I confess to feeling much at home here to-day, for several reasons. In the first place, my young friends in the corner remind me of the days when I too was a college student; in the next place I find prominent in the decorations two flags entwined, one which I have been taught to love, the other one which I have learned to respect. Then I meet here my friend of recent acquaintance, the honored Mayor of Montreal who greeted the members of the American Institute of Mining Engineers so cordially on our arrival, and I feel still more at home when I see close beside me Premier Fielding, because the other night he and I tried to see who could get closest to the ceiling of the St. George's Club. I think I am ahead of him by some six and a half inches, measured by a snow-shoer's welcome. But, Mr. Chancellor, with the audience before you and the gentlemen here to entertain, I need do no more than offer congratulations. I would therefore congratulate his Excellency on having such a permanent and useful addition to the development of the Dominion. I would congratulate the Mayor of Montreal upon having another beauty added to this magnificent city; I would congratulate the Faculty upon having the means of giving at McGill University, a higher education to a great number of young men who will come to the University, and I would certainly not forget to congratulate the gentleman who is able to see the completion of a magnificent dream carried out through his public spirit to a magnificent reality. I have said that my friends in the corner make me feel at home; probably, I should say a word to them. We know of McGill University, and we know of its Faculty; we have seen this building, and I would say to you young men who are students in this department that if McGill does not turn out the best engineers in the world, it is your own fault.

MR. CHARLES MACDONALD,

Vice-President of the American Society of Civil Engineers.

It is with special gratification that I am permitted to be present on this occasion, to offer, on behalf of the American Society of Civil Engineers, its hearty congratulations upon the inauguration of a new home of science in connection with McGill University, and to render its tribute of honor and respect to the large-minded generous citizen who has, so wisely and so well, disposed of the means with which Providence has blessed him, to the lasting benefit of his fellow men.

It is eminently proper, and of necessity even, that this great Seat of Learning should include in its environment a school for the education of Civil Engineers, thereby expanding its curriculum in the direction of Science applied to Construction, and presenting increased facilities for the student to acquire such portion of the general stock of knowledge as he may best be qualified by Nature to assimilate.

Much has been said, in a controversial spirit, upon the relative merits of Classical and Scientific education; but the better judgment of thinking men is rapidly leading them to the conclusion that classical training, combined with scientific methods of investigation, will best equip the student for the great Battle of Life. An Engineer certainly cannot hope to impress his clients with the merits of any project, unless he can clothe his reports in language which has an attractive literary quality, independent of the technical interests involved, and, with equal force, may it not be said that the advocate or clergyman should be duly impressed with the importance of mathematical accuracy, before giving free vent to his imagination, or allowing his oratorical powers to carry him beyond the region of demonstrable fact. After all, the education of the schools should be so ordered that the man, when brought in contact with the real facts of Life, may be able to observe with clearness of vision and direct his course, along the "lines of least resistance," to the accomplishment of legitimate purpose.

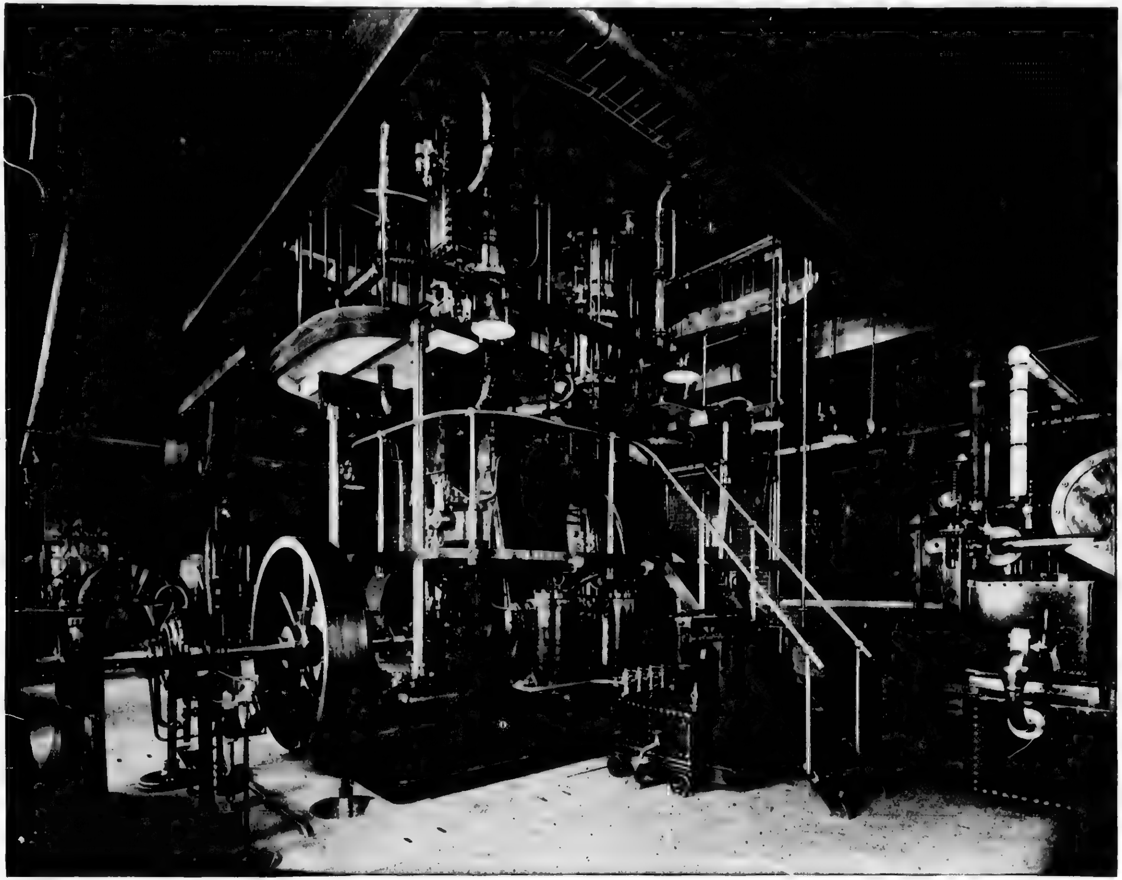
Whatever may be said of other callings in Life, it is undoubtedly the fact that the Engineer is a true cosmopolitan.

He is never received as a foreigner from whatsoever country he may come. Wherever his ability may enable him to suggest methods whereby the Forces of Nature can be utilized for the general good, there is he welcomed with hearty Good Will. He belongs, in fact, to a Universal Brotherhood, of which Canada has furnished to the Society which I have the honor to represent, not only many distinguished members, but an honored and honorable President, of whom not only his nation but the profession at large may well be proud. We hope for many further acquisitions from the same source, and that the school now so happily inaugurated may furnish new men to swell the ranks, where they will be received with open arms and warm hearts.

If I may be pardoned a personal reminiscence in closing, I should like to say that not many years ago (as it seems to me now, looking backward) I had just completed an experience as chainman and rodman on the original surveys of the Grand Trunk Railway between Kingston and Brockville, then under the direction of the late Samuel Keefer, and was anxiously looking forward to an appointment upon construction, as the next regular step to be taken in acquiring a practical knowledge of the profession of my choice, when to my utter chagrin, the chief informed my respected father that, if "that boy of his ever expected to become an Engineer, he had better be sent to school." Unfortunately, Canada did not at that time possess any institution for scientific training. In fact, the only one worthy the name on this continent was the Rensselaer Polytechnic Institute at Troy, New York. To this my steps were directed, at Mr. Keefer's suggestion; and from it, I return in due course, as a transplanted Canadian so to speak to emphasize the necessity which has given birth to a similar school on this side of the St. Lawrence; to extend to our Northern Sister the right hand of fellowship; and to wish her an unlimited measure of success.

SIR CASIMIR GZOWSKI, K. C. M. G., A. D. C. to the Queen.

It is hardly fair, to ask an old man like myself to make a speech, unprepared and uninformed that I was to be called upon, after the most valuable remarks that have been made upon this interesting occasion. But as you have called upon me I have only a few words to say, and my remarks will be to the students in the corner over there. I have been myself in that corner. I was educated in Russia and obtained my commission as an officer of the Royal Engineers of Russia, when I was about the age of the majority of you. I am not going to enter into my personal history, but good fortune brought me to Canada, and has made me a faithful and loyal subject of the Queen. I commenced practising my profession without any such building as this, without any of the appliances about which you have learned so much. At that time there existed a book known as 'Barlow on the Strength of Materials." I venture to say some of you have looked over that book, but from your cellar to your garret you have Barlow everywhere. You have my heartiest congratulations, and for the future years of my life I shall always feel the deepest gratitude to Mr. McDonald and Mr. Workman and to those who have given you an opportunity to acquire knowledge which in the olden days was impossible. I will not detain you with any longer remarks, but wishing success to McGill University, and feeling the greatest obligation to Mr. McDonald and Mr. Workman, I wish you God-speed.



EXPERIMENTAL ENGINE.

MR. THOMAS C. KEEFER, C. M. G., F. R. S. C.

I feel very grateful indeed for the honour of this occasion, due, I think, to the exceptional circumstance that I was nominated the first professor of civil engineering in McGill. I was a professor without a class to begin with and also without a salary. I suppose it was owing to that fact that I have been warned not to say much to-day, and hence you will not expect a great deal from me. I therefore, will confine myself to representing, as I do, the Canadian engineers who are not present, and tender their warmest gratitude to Mr. McDonald for his noble gift, and also to express the pleasure and satisfaction we feel that he is here to see its completion. He is one of those men who, in common with other noble Montrealers, yourself Mr. Chancellor included, have been wise enough to recognize the noblest use of wealth. All engineers will, I am sure, join with me in wishing that Mr. McDonald may long live to see the fruit of his labours.

MR. R. W. RAYMOND, Ph.D.,

Ex-President of the American Institute of Mining Engineers.

Ever since we came to Montreal, we Americans of the United States, to visit the Americans of Canada, we have heard on every occasion how little difference the boundary line makes in the warm feelings with which the people on both sides regard one another. That was very pleasant to hear at the beginning, but bye and bye I began to feel methinks they did protest too much, and I am going to show you how little I think of the boundary line by not saying anything about it. I stand before you to represent for the moment what Principal Grant, though not with perfect seriousness, called "the vulgar business of mining." As secretary of the American Institute of Mining Engineers, which includes Canada as well as the United States in its membership, I feel bound to stand up for my profession and my Society, and since my good friend Mr. Charles Macdonald, in his minor capacity of vice-president of the Society of Civil Engineers, has eulogised that profession before you, I feel it necessary to inform you that when he is at his best it is as a private member of the mining engineers. We lend our privates to be officers of the other society. But in the Institute of Mining Engineers we don't draw any distinctions between engineers. Mining and electrical engineers belong to us, and we belong to them. If you will allow me, I would like to direct your attention for a moment or two to the part which the engineer has played and is playing, in the modern world. There are two kinds of folks—the Philistines and the Saints. The Philistines are the folks that do things, the Saints are the folks that sit on the fence and criticise. The engineer is the Philistine of science. He is the one that goes out and grapples with the problems, overturns the obstacles, conquers the difficulties, does the thing. The Saints occupy themselves beforehand by saying how it cannot be done, and afterwards by explaining how it was done. You will find that distinction running away back into Scripture history. The children of Israel were Saints in their own estimation, but on one occasion they found they could not overcome the Philistines, because the Philistines had blacksmiths and the children of Israel had not. On another occasion they returned defeated, because they encountered chariots of iron, which they could not make themselves, and so, in the age of direct divine guidance, Providence could not do better than teach them to learn from the Philistines. What have we Philistines been doing? We have not had our chance until recently; the Saints have had the world, and a pretty mess they made of it. Baker describes very vividly, in the account of his Abyssinian travels, how the great flood of the Nile originates in the rains of Abyssinia, which give rise to thousands of freshets, and these rushing down the mountain sides and coming together, swell the main river into a solid wall of water and form the stream which is the pulsating life of Egypt. Something in that style the effect of the accumulated inventions of the nineteenth century came on about twenty years ago. In the first place, it has been a time of business depression for twenty years. The old houses find out they cannot do business in the old way. Fifty per cent. of the fixed capital we had has been destroyed in the last twenty years; forty per cent. of the employed labor we have, has been dislocated in the last twenty years and set to seeking new occupations. There has been economic disturbance, most intense in civilized countries, and scarcely felt in savage countries. It was the Philistines getting in their work. What did we do when we finished the Suez Canal? (If poor de Lesseps had not stopped being a Philistine and tried to be a financier, his sun would not have gone down in dishonor.) What we did was to change for ever the old currents of commerce, which had in succession enriched the cities of the Mediterranean, Spain and Holland. The Suez Canal cut short the voyage to the East, but it left to decay 2,000,000 tons of shipping that was no longer required, and the further development of its use has destroyed three successive fleets of steamers, each in turn being superseded, long before it was worn out, by some new improvement. That has been done; and the nemesis has come upon London, which had become the entrepôt of the world, by the laying of the ocean telegraph cable. If I want to buy wool I don't write to London, I cable to Australia, where it is loaded and comes straight to my port. A chemist made a quiet invention. His name was Henry Bessemer, now Sir Henry Bessemer. A group of engineers went to work with that invention, foremost among them a countryman of my own, and they have developed it to such an extent that you in Canada, as well as we in the United States, know what a potent distributing factor it has become in the world. What ails Ireland? I will tell you. Wheat

coming on Bessemer rails, and making it impossible to pay rent in Ireland, is what ails Ireland. You won't be able by any advice to parliament or legislators to cure the trouble of Ireland. You cannot make Irish farms pay if it is possible to bring into competition with them the area of the Red River, or the corresponding area of Oregon and Montana. But let us look at the counter side. One stupendous astonishing fact, unique in history, is that that this poor old world of ours, for the first time in thousands of years, is getting rich. Did it ever occur to you that in all the centuries past, men have scarcely succeeded in doing more than feed themselves and clothe themselves, with a little beggarly remnant represented in a few cathedrals and works of art, and a little gold and silver. We are adding on this continent—you in Canada, as I am satisfied from my inspection in Montreal, and we on our side—every year more than half a century's accumulation of the past times; and we are able to do it without feeling it. It is the most overwhelming proof that we do save money every year. Yes, the world has been able in the last twenty years to wipe out half of its invested capital and yet do so much better than ever before that it saves money and is getting rich for the first time in its long rugged history. Who did that? That is where the fine work of the Philistines comes in. We have simply by the applications of science given humanity the biggest lift it ever had. We have made the civilized man equal to a dozen savage men by equipping him with steam engines, chemical laboratories, and the means by which he can utilize the forces of nature around him. What the Philistines have brought to life is man, plus machinery, and it means a dozen times the previous man. We took hold of the one weak spot in the world, and that was man. Some of you have not waked up yet; but in spite of all the shaking of heads, which venerable saints still indulge in, we Philistines know what we are about. The effect of science is to enable us to increase wages, while decreasing prices; to make people rich, while demanding they shall shorten the hours of labor, and yet have more work done. I think it is unnecessary to say that I perfectly believe in all the religious motives for such service; and I may say for myself I would not give an hour to the labors of my profession if I did not believe it to be a branch of the service to my God and my fellow men. Notwithstanding, if there be any who cannot appreciate that motive, I say the man who cannot understand the immediate, direct value of institutions and agencies like this splendid School of Applied Science, is so far beneath the level of the intellect of a Philistine that I don't know how to get at him. In closing I will simply say that, as a representative of this "more vulgar branch" of the profession, I recognize, with a hearty enthusiasm, the perfectness and completeness of all I see around me. It is in no spirit of criticism that I say we mining engineers will be glad to hear you have some day got chemical and metallurgical laboratories of immense and direct practical value, in which ores and minerals and machines are tested, and where tests are being daily made for the benefit of citizens. Besides the good such things really do, there is another great advantage in them, viz., we are able thereby constantly to prove to people who may not appreciate the higher things of science, that it can do them some good. I thank you for your kind attention, and beg leave to tender my personal congratulations to the authorities, to the Governor-General and to Mr. McDonald.

PROFESSOR BOVEY, M. Inst. C. E., D. C. L., F. R. S. C.,

Dean of the Faculty of Applied Science.

To-day we have listened to many brilliant speeches from His Excellency and from other distinguished visitors, and on the part of our Faculty, I beg to thank them for their presence with us and for the words with which they have encouraged us. Will you also allow me to express our very deep regret that the state of Sir William Dawson's health has made it impossible for him to be here on this occasion. His great efforts in the development of the scientific side of the University are too well known to all of you to need any comment from me. The ceremonies of to-day seem and indeed are incomplete without him whose own interest has always been made to give place to the interest of the University. With your permission I will now read a note just received from Sir William

St. Augustine, Fla., February 15, 1893.

Dear Professor Bovey:—From my distant place of sojourning, permit me to congratulate you on the celebration to take place on the 24th, and which marks the culmination of a long series of efforts to establish a thoroughly efficient School of Applied Science in connection with McGill. You must rejoice in this consummation, though even now it is not the time to lay our armour down. Great though the gifts are that you have received, there is still room for further growth; but a firm foundation has been laid in the noble benefactions of Mr. W. C. McDonald and Mr. Thomas Workman, on which I hope the University will be able to build in a manner adequate to the growing needs of the Dominion in the matter of Applied Science.

With kind regards, yours sincerely,

J. Wm. DAWSON

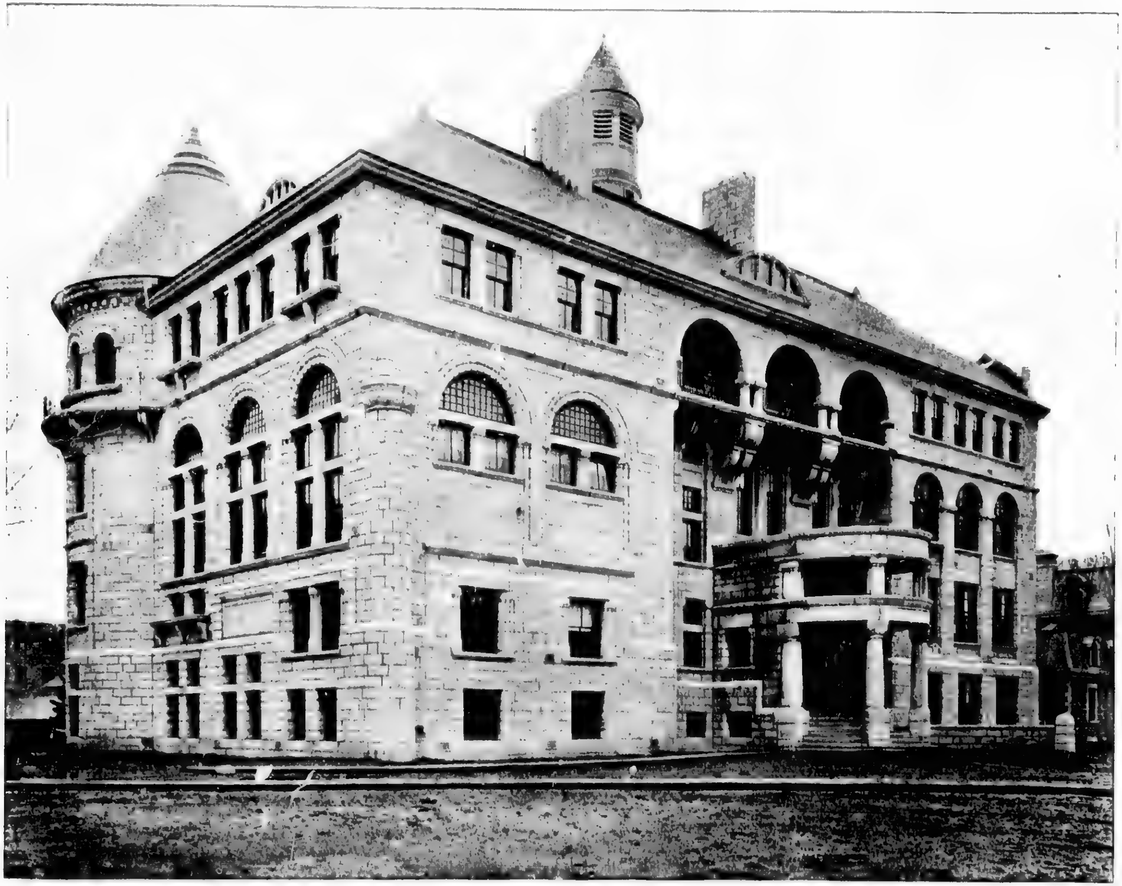
Your Excellency and gentlemen, when we enter the buildings of this Royal Institution and think of the noble men who have rendered their erection possible, we cannot but feel proud that we have amongst us citizens who have recognised the noblest uses of wealth. Having satisfied themselves that the true greatness of a nation depends not so much upon its material progress as on the enlightenment and character of its people, they have endeavoured to give all help and encouragement to those who desire to follow the path of progress. This particular building in which we are now gathered is, as you may have observed, completely equipped for scientific investigations in all departments of engineering and we wish it to be fully understood that the practical applications here taught are to be considered in the light of scientific experiments, that is, that their chief use is to teach scientific truths in the clearest possible manner. If they give the student at the same time a fair knowledge of the use of his future tools, surely so much the better. Indeed Your Excellency, it would seem as if unparalleled progress should now be before us. But even in this age of machines none has yet been invented into which we can put the raw material and turn out a student. The best equipped university is but the sword, which may lie rusty in the scabbard, or, in the hands of strong men, may be turned with full effect against the ranks of ignorance. And just here comes in the work both of professor and student. A keen sense of contrast, of admiration, of almost personal gratitude, will surely suffice to impel *us* to vigorous action. Have we reasonable hope that our successors will not lay down their weapons? The deeds of some men of the past and of the present should teach us hope for the men of the future

"Men the workers, ever reaping something new
That which they have done but earnest of the things that they shall do."

Or, if I may so use the words of another of our greatest thinkers

"Every gift of noble origin
Is breathed upon by Hope's perpetual breath."

An adjournment was made for luncheon, after which the company re-assembled in the lecture theater, in the Physics Building.



McDONALD PHYSICS BUILDING.

[illegible] TAYLOR, [illegible]

THE McDONALD PHYSICS BUILDING.

The opening ceremony connected with the Physics Building took place at 4.15 p. m., in the Lecture Theatre, which was filled with [illegible]

The Chancellor, Sir Donald A. Smith, opened the proceedings by calling upon Prof. Cox to address the gathering.

PROFESSOR COX, M. A.

Some two years ago, at the meeting of the Royal Society, when this building existed only on paper and in the minds of those [illegible] it. Your Excellency was pleased to express the hope that you might still be with us when the opening took place; and to-day we [illegible] to see the full realization of that kindly wish. Inas-much as there will be less time for visitors to examine this building [illegible] opened this morning, I have been asked to say a few words explaining its character and purpose. I think I shall be right in saying that [illegible] this building was practically an incident in the development of the Technical Building which was opened this morning, and those [illegible] the scale upon which that building was carried out will not be surprised at the magnitude to which a mere incident has grown. But [illegible] very apt to grow under our hands. And, now, when we look at our completed plans we observe in them a three-fold purpose. In [illegible] we feel this building ought to supply to the University, and especially to the Faculty of Arts, the means of teaching properly one of [illegible] important branches of modern education. A knowledge of physics is now-a-days a necessity in any liberal education, and no curriculum [illegible] of liberal can afford to ignore the study of the laws of nature and the methods of the science of investigating them. Next we may say [illegible] for its purpose, and, perhaps, the original purpose, the providing of that training in the principles of science which is necessary, [illegible] to the proper use of the facilities for the study of applied science, no less than for the students of medicine in the beginning of their [illegible] who take up practical chemistry for their study. In this building we hope to provide that instruction in electricity, magnetism, [illegible] light which shall save many years of labour to those who take up the study of these branches of knowledge. Last, but by no means [illegible] purposes which have been held in view while we were preparing the plans and equipment, we trust this building will play an [illegible] the prosecution of research, tending to widen the bounds of our knowledge of nature. In saying that I must guard myself against [illegible] that the work to be done in the building opened this morning is not to be counted as research. I re-echo every word that fell from [illegible] The work in the Applied Science Course is to be counted as strictly a part of a liberal education, as any work we shall do [illegible] But there are researches and researches. There are some which can only be carried on to a satisfactory issue if you have at your [illegible] great and powerful machines which are to be found in the Engineering Building. On the other hand, there are researches which require [illegible] apparatus that they could not be conducted in the midst of moving machinery and powerful currents traversing the building. For this [illegible] building has been adapted, and one thing in which we have been fortunate is that by having two such buildings to plan at the same [illegible] to separate the moving machinery from the more delicate apparatus to which I have referred. With this three-fold purpose [illegible] to be fortunate in the means for carrying it out. In the first place, we found in our benefactor a man who would spare [illegible] reasonable means to carry on what we thought our proper work required from first to last. Whether it has been a question [illegible] or of the equipment, I have heard no other language from Mr. McDonald than what was said this morning "Let us have [illegible] best," with a definite aim for everything, but always the best. Sometimes I found a difficulty in choosing between first-class makers [illegible] first-class instruments, which almost made me feel it a grievance that he had not put upon me a price limit, so that I should be compelled to say, [illegible] have this." Again, I think we were singularly fortunate in having behind us the experience of twenty-five years of buildings of this [illegible] When Prof. Clerk Maxwell, twenty-five years ago, began to build the Cavendish Laboratory in England he had to work out from the [illegible] everything upon which it depended. Since that time physical laboratories have been built in large numbers in England, Australia, and [illegible] the United States. We have had the benefit of that experience, have drawn from the experience of Australia, France, Germany, and have [illegible] from the new laboratories in the United States. I was sent to eight principal universities in the United States. I visited Prof. [illegible] at Harvard; Prof. Cross at the Massachusetts Technical Institute; Prof. Rowland, Baltimore; Dr. Wright, Yale; Dr. Kimball, Worcester; [illegible] Barker, of Philadelphia, whom we are delighted to have with us to-day, and Prof. Nicholls, at Cornell. I found these gentlemen at the beginning [illegible] and preoccupied to the last degree with the turmoil of starting up their work, yet, in the few days I was able to spend with them, they [illegible] aside, as much as possible, their work, and devoted themselves to giving me the benefit of their experience, with as much zeal and interest as if they had been building laboratories for themselves. There is one point for which I am particularly grateful, they showed me not only what had

succeeded, but pointed out what they considered failures, so that we might profit by their experience, shewing that in science there is neither tariff nor trade rivalry, but all are concerned in getting the best means for study. There is another thing in connection with these buildings which I should be very ungrateful not to mention. In our architect Mr. Andrew Taylor we were fortunate in finding a gentleman who brought to this novel task a mind singularly free from prejudice and untampered by traditions, and full of keen interest in the problems to be solved. All our difficulties he met with an endless fertility of resource, and spared no pains to make the building what it should be. It was not until after many months of careful study of the various problems connected with the proper place and relative position of the different rooms, and their requirements of stability, light, etc. had been laboriously worked out, that any attention was given to the outside, generally so dear to an architect, and when he came to it I think his choice of the Romanesque style the type of stability and permanence, has been fully justified by the way in which it has worked out. How far he has succeeded in investing our strictly practical needs, with outward dignity and beauty, it needs no words from me to explain ; I leave everyone to judge for himself. With regard to teaching in the building, we have gained again three departments. We have provided in the room in which we are now assembled and in two others on the floor above, the facilities for teaching by lectures, which are recognized as a necessary part of the work. Near here are the apparatus rooms. At the other end of the building we have four large laboratories. The elementary laboratory, in which the usual beverage will be served later on, is put highest, because it needs less stability and perhaps more light and space. There is one laboratory for heat, and another for advanced students in electricity, and lastly there are rooms in the basement devoted to research. We have our solid piers carried through to the foundations ; and one end of the building is kept free from iron as much as possible. Above us are rooms devoted to physics. As to the equipment, a word or two may be desirable. We have instruments, good of their class, but still of a simpler character for the elementary work, generally in the first year. We have apparatus for illustrating lectures, and instruments for first-class research and fourth year work, which it would be difficult to match in any part of the world. The choice of this apparatus was difficult, because it was limited to choosing only good things. There are few first-class makers unrepresented in it, and none but first-class are represented in our collection. With this, then, in our favor, we ought to find it in our power to do first-class work. We have a splendid collection of resistance boxes, and these are, perhaps the one article in which I have been almost extravagant. I think it would be difficult to match the collection in any other laboratory. In regard to electrical standards, we have no less than thirteen coils tested at Cambridge, England, and have the latest means of comparing others with these standards, including a special duplicate of the Carey-Foster bridge, used by the British Association Committee for testing at Cambridge, which was presented to us by the late Duke of Devonshire as a mark of his interest in scientific education on this side the water. It would be out of place to take you through the instruments in Heat, Acoustics and Optics, it is enough to say that every department as far as we have had the forethought to provide for it, has been provided for, although you will only see about two-thirds of the collection here to-day, because it has only arrived lately, and has not yet been set up. If any of you should see imperfections in what ought to be a perfect building and equipment, I really do not know where to turn to lay the blame, except it be upon myself, for I have no excuse to make either on the ground of benefactor, architect, or friends who have helped me. Such, Your Excellency, is the building you will be called upon to open. We appeal to you with some confidence that you will, upon inspection, find it worthy of the high purpose to which it has been dedicated, worthy of our great and growing and most beautiful city : worthy of the proud site it occupies beneath the shadow of our royal mountain and overlooking our royal river, worthy of this noble seat of learning, already ancient according to the years of a man, but barely entering as yet on the first flush of vigorous youth, and worthy of this vast Dominion, to every part and province of which may it be destined to render signal and lasting service.

HIS EXCELLENCY, THE GOVERNOR GENERAL.

After the admirable and clear exposition of the purposes and design of this building which we have had from Prof. Cox, I should feel I have no right whatever to trespass upon your time, even if I had not already done so in the case of a good many of you, during the kindred proceeding of this morning, in the adjoining building. I trust, however, you will allow me to say a very few words in connection with the pleasant duty imposed upon me, and once more to congratulate the university upon the two noble additions which have been made to this city by your munificent townsman, Mr. McDonald, who I am glad has seen so successful a realization of his fondest hopes. It has always been to me a subject of admiration to see how, when great fortunes were accumulated in the United States, the minds of those who acquired them, in many instances turned at once to placing amongst those persons among whom they had been brought up, some enduring and useful monument, it might be to the donor, but more often conferred in the sole interests of science and the progress of the country. It is, therefore, a matter of congratulation for us to feel that in this way your noble city leads in the path of science, and that there have been for many years past those connected with this university who have spared no money, no pains, no trouble to endeavour to place a monument before the citizens in a form which, if it commemorated themselves, did so only in association with the promotion of science. I should verily believe in the case of Mr. McDonald he would have been glad if, in his efforts for the advancement of

science and the welfare of his friends, even the slightest notice of his own name had been struck out. But happily in this country, the will of the majority prevails, and I think that without taking any formal vote, we shall one and all agree that the events of this day will have more than ever endeared him to the hearts of all connected with the university and scientific training; and I do, sir, on behalf of those present, desire most heartily to express our delight that you have been spared in such health and strength to see your proposition entirely realized. It is a dangerous prospect indeed that Prof. Cox has laid before you, that your very kindness is possible to be looked at in the form of a grievance. I think many placed similarly to himself would be extremely pleased to have a grievance of such a character. I cannot conceive anything which would be more likely to endanger the success of scientific education than being restrained by conditions of dollars and cents from getting that which is the very best for the purposes of teaching and investigation. Your ample munificence has spared us any such conditions here. Those young men, I trust, who will make use of the material assistance with which you have provided them, will feel it is their own fault alone if first-class men are not turned out from this building. I am not going to make a speech. I can only once more repeat I am indeed glad as the official Visitor to be associated with you on this occasion. I congratulate the university upon your noble gift, and you, sir, upon the grateful manner in which it has been, and will long be received. I now have the honour to declare this Physics Building open for the purposes of science.

PROF. BARKER,

of the University of Pennsylvania.

I have come here this afternoon, not to make a formal address, but simply to bring to the authorities of McGill University the greetings of the University of Pennsylvania and of the friends of scientific and technical education across the border, and to tender our congratulations in common with the many which will be offered, to Mr. McDonald to-day, upon this new departure.

Perhaps there is no demand of the times that is more imperative than that which requires breadth in education. And probably also there is no educational problem which is more difficult of satisfactory solution. We hear much of liberal education, it is true; but we observe not infrequently that those who thus speak of it, apparently acting upon the *lucus a non lucendo* principle, are scarcely liberal in extending its boundaries. It is pertinent then to ask in what does an education in the liberal arts consist? In 1852 there was organized in the University of Pennsylvania a Department of Mines, Arts and Manufactures; and this Department existed side by side with the Classical Department. Evidently in this case at least, the claim so often made that only the classical course constitutes the department of arts in a University, can scarcely be admitted. In this discussion moreover, the question what place the sciences shall have in a course of liberal education, is a most important one. It is a question which we in Philadelphia in common with many others of our larger institutions, are just now considering with great care. Why should not courses of liberal education be established, all leading to the degree of B. A., in which mathematics, science, history or literature shall severally predominate, as well as courses in which the classics are pre-eminent? Are not literary culture and scientific culture as truly liberal culture as is classical culture? Trade is regulated we are told, by the laws of supply and demand. Why should not our Universities heed the demand of the times and provide such a broad and liberal education as is made possible by the marvellous progress in ideas which the present century has witnessed. Indeed is it not to assist in inaugurating such a course of scientific and technical education in McGill University, that we are met here to-day?

This question, however, is by no means a modern one. Allusion was made this morning to the fact that McGill University exists in virtue of rights secured by royal charter. The University of Pennsylvania, when it was originally established in 1749, also derived all its rights from the Crown. The plan under which it was organized, first as the Academy of Philadelphia, was drawn up by Benjamin Franklin. This plan, while assigning to English studies the pre-eminent position, yet provided liberally for the classics. "All intended for divinity" it declared "shall be taught the Latin and Greek; for physics, the Latin, Greek and French; for law the Latin and French; merchants, the French, German and Spanish; and though all should not be compelled to learn Latin, Greek or the modern foreign languages, yet none that have an ardent desire to learn them should be refused, their English, arithmetic and other studies absolutely necessary being at the same time not neglected. That curriculum provided a liberal education; but the classicists ere long acquired control of the university, and in 1789 Franklin entered a most forcible and vigorous protest against this perversion of the original trust. In this protest occurs this celebrated passage: "At what time hats were first introduced we know not, but in the last century they were universally worn throughout Europe. Gradually, however, as the wearing of wigs and hair nicely dressed prevailed, the putting on of hats was disused by genteel people, lest the curious arrangement of curls and powder should be disordered, and umbrellas began to supply the place. Yet still our considering the hat as a part of dress continues so far to prevail that a man of fashion is not thought dressed without having one, or something like one, about him, which he carries under his arm; so that there are a multitude of the politest people in all the courts and capital cities of Europe who have never, or their fathers before them, worn a hat, otherwise than as a *chapeau bras*, though the utility of such a mode of wearing it is by no means apparent, and it is attended not only with some expense, but with a degree of constant trouble. The still prevailing

custom of having schools for teaching generally our children in these days the Latin and the Greek languages, I consider, therefore, in no other light than as a *chapeau bras* of modern literature." May we not say, in the light of a hundred years of experience, that the teaching of any subject which does not more or less directly advance the particular studies the student has in hand is also a *chapeau bras*.

We are met here to-day to open a building provided by the munificent liberality of Mr. McDonald for instruction and investigation in physics. What is this physics, or natural philosophy, its earlier name, which thus receives such a magnificent building? "Natural philosophy," said Newton, "is the investigation of laws in the material world and the deduction of results not directly observed." The greatest authorties of our time tell us the same thing. Clerk Maxwell says: "We owe all the great advances in knowledge to those who endeavor to find out how much there is of anything," and Lord Kelvin says: "One's knowledge of science begins when he can measure what he is speaking about, and express it in numbers." The statement of Lord Bacon that "while in all other pleasures there is satiety, in knowledge there is no satiety, but satisfaction and appetite are continuously interchangeable," is eminently true of the knowledge of physical truth. In opening the Cavendish laboratory Clerk Maxwell said: "Experiments of this kind—those in which measurement of some kind is involved—are the proper work of a physical laboratory." The grand idea then which underlies the study of physical science is the investigation of the phenomena of the material world; and therefore the highest object of this physical laboratory will be the training of investigators. There is no feeling I suppose, grander, or more magnificent, than that of standing face to face for the first time with a new truth. There can be no higher mission in this world than the mission of investigating such truth. Scripture tells us: "Thou has put together *all things* in measure, and in number and in weight, and when the student in the physical laboratory investigates the things that are in number, and measure and weight put together, he investigates the grand things of creation, which have been made by the Great Creator for this very purpose. But this is not all. This Lecture Theatre, and the equipment which has been here provided, show us that instruction for purposes of application is another object of this laboratory; and here I am impressed by Clerk Maxwell's remark when he took the professorship at Cambridge. He said: "There are two parties about the professorship. One wants popular lectures, and the other cares more for experimental work. I think there should be a gradation—popular lectures and rough experiments for the masses, real experiments for real students, and laborious experiments for first-rate men."

Who now are the men who have raised physics into its present position. I may mention as typical examples the names of Faraday and of Maxwell abroad, and of Franklin and of Henry in this country. To whom was it that Cyrus Field went when he wanted to know if the Atlantic Cable was possible? To Faraday, and Faraday said: "I doubt whether it is possible." "Solve your doubts," replied Field, "and the Company will pay the expense." Faraday said: "I will solve the doubt but shall take no remuneration." Upon Field's second visit Faraday said: "You can send a message, but it will not be instantaneous." "How long will it take?" asked Field. "It will take at least a second" was the reply. "That is quite quick enough for me," remarked Field; and the cable went down. When Graham Bell wanted to know about the principles on which he was making the telephone, to whom did he go for advice but to Prof. Henry. Henry said to me himself that he never had passed a pleasanter hour than when in Daniell's laboratory, he met Faraday and Wheatstone and they tried to obtain the thermo-electric spark. Faraday tried and no spark was obtained. Wheatstone tried, and still no spark. Henry was asked to try; he used the principle of self-induction which he had himself discovered in 1832, and instead of having the wire straight, he wound it round a core of iron and got the spark. Faraday capered round the room like a boy shouting: "Hurrah for the American experimenter!" It is a gratifying sequence that Faraday and Wheatstone petitioned the Royal Society to grant Henry the Copley medal for these investigations. These two men, Faraday and Henry, were much like each other in that they declined all commercial connections with their investigations. Their statements are so nearly alike, that I trust I may be permitted to call your attention to the way in which they put it. Faraday said: "I have rather, however, been desirous of discovering new facts and new relations dependent upon magneto-electric induction than of exalting the force of those already obtained; being assured that the latter would find their full development hereafter.' Henry says: "I have sought however, no patent for inventions, and have solicited no remuneration for my labors; but have freely given their results to the world, expecting only in return to enjoy the consciousness of having added by my investigations to the sum of human knowledge and to receive the credit to which they might justly entitle me." Such are the men who have brought physics into its present condition.

As the result of investigations made by men such as these, we are called upon to-day to witness a broadening of the horizon of thought more rapid than the world has ever before seen. As an example, we may take a recent experiment made by Mr. Preece, the electrician of the British Post-Office. He put up a wire nearly a mile long on the coast near Tavernock, a little south of Cardiff, and a shorter wire on Flatholm, a small island three miles off in the Bristol Channel. And he found that by means of alternating currents generated in the former, Morse signals could be projected across this intervening space, and messages could be received upon the shorter insular wire; the electromagnetic waves generated in the aether by the to and fro current being transmitted with the speed of light and concentrated upon the receiving wire. If this is possible may not the future witness the establishment of communication without metallic conductors not only between distant stations on the earth but also between the earth and Mars or even Sirius. Indeed may not telepathy itself be simply a phenomenon depending upon aether waves?

Can we wonder that some of these great men who have given their lives to these investigations should earnestly desire to come back and see what the outcome has been? You have, perhaps, heard the story of Franklin, who wrote to a friend on the question of the vitality of animals. He was walking near Paris one day, and was shown a toad and the hole in the rock where it was asserted to have been; but the evidence was not quite sufficient to convince him that the toad had really been there. Going home and opening a bottle of Madeira which had been sent by some friends on the other side, he wrote: "I found three flies in the bottle, and bethinking myself of the toad, I took them carefully out, laid them on a sheet of paper, placed them in the sunlight in the window, and two of them flew away." I hope I do not impair the veracity of my distinguished countryman. "I wish," continues Franklin, "it were possible from this instance to invent a method of embalming drowned persons in such a manner that they might be recalled to life at any period, however distant; for, having a very ardent desire to see and observe the state of America a hundred years hence, I should prefer to any ordinary death the being immersed in a cask of Madeira wine, with a few friends, till that time, to be then recalled to life by the solar warmth of my dear country.

To educate students so that they shall become familiar with the mighty energies of nature, and to train them up so that they shall be able not only to investigate these energies but also to extend and develope their useful applications, is the function of the department which now takes possession of this building in which we are assembled. We have all been delighted with the admirable manner in which it has been arranged to suit the various subjects and methods of physical instruction. We have all been surprised at the excellence of its equipment. It is fitting therefore that I should congratulate most heartily all those who have been concerned in its creation as well as those who are interested in its success. I would especially offer my congratulations to the Governor-General, if he will allow me, that he has been so fortunate as to connect an event of this importance with the brilliantly successful administration which he has given to the Dominion of Canada. I want to congratulate my excellent friends the Chancellor and the Principal, the Board of Governors on these fine buildings and their fine equipment, but I want to congratulate them more on the acquisition of two such men as Profs. Bovey and Cox, to design these buildings and to select their equipment. I want to congratulate Prof. Bovey that he has been permitted to see the realization of his fondest hopes, that he has succeeded in producing here an institution of engineering which is unsurpassed on this continent. I am greatly interested in the experiment he has here in hand, *i. e.*, the taking out of the Physics Building of those larger experimental machines which can more perfectly and more satisfactorily be used in the engineering laboratory. And last but not least I desire to congratulate Prof. Cox on the possession of the finest physical laboratory in America.

To provide institutions of learning with the facilities for a broader and more profound education is one of the noblest uses of money. Such beneficence rears a monument to the memory of the donor far more honorable and enduring than bust or cenotaph. Mr. Lick originally intended to immortalize himself by erecting statues of himself and family in San Francisco. A friend pointed out to him that the guns of a hostile fleet might destroy them in an hour What shall I do with the money then? The answer was the Lick Observatory. I would offer my congratulations to the benefactor of McGill, Mr. McDonald, but I do not think he needs congratulation, I think he needs felicitation more. The sense of good deeds done cannot be expressed in words, but as the years roll on and he lives and moves among you, these buildings and the work done in them will be the reward he receives for his generous liberality. The scientific work of the students who graduate from the engineering and physics departments will ever be the noblest monument to Mr. McDonald's munificence.

DR. HENEKER,

Chancellor of the University of Bishop's College.

Although suffering from indisposition this day, and hardly able to address you, as I should like to do, I am here to offer you the congratulations of the sister protestant University of this Province, on this great occasion.

Nothing has occurred within the past few years which has created such an interest among university men in Canada, as the opening of these science buildings. Science as was said this morning, is a large word comprehending many things. The study of the Classics is a science, Archæology and many other subjects not commonly classed as scientific pursuits are none the less sciences. The word simply means knowledge apart from the application of knowledge, which is art. The congratulations of all scholastic institutions throughout the Dominion will be evoked by this noble gift to McGill, and for her wise selection of the men who are to take the management of these schools, Prof. Bovey and Prof. Cox, who will, I am convinced, prove themselves to be competent for the positions they are called upon to fulfill. They have come to us from the Mother land, devoted to scientific research, to fill a place in this new country helping us onward in the acquisition of knowledge. As was well said this morning "Science

has no country" "it is Cosmopolitan." In days gone by we find that Erasmus accepted an important position in an English University, and Max-Muller is a recent example of the same kind. We in Canada freely accept men from the United States, and they in like manner have no compunction in appointing Canadians to high positions in their seats of learning. Science therefore has no country; it is one of those grand bases on which all can meet.

We ought not in contemplating these buildings, to lose sight of the architect, Mr. Taylor. I myself have already had the privilege of his acquaintance, for he was the architect of our new school building at Lennoxville. He has there given us a building practically fire-proof, of which we are proud, and which is in every way well adapted to its purpose.

I can perhaps testify to this the better because my own early training was for the Architectural profession under Sir Charles Barry, the architect of the New Palace at Westminster. I have therefore some knowledge of the difficulties, which surround such as undertaking as this, and I can add my testimony to that of Prof. Cox that "Mr. Taylor brought a clear mind to the work of these buildings, and has solved the problem."

I should like also to say one word about the great object of university training. It should, if possible, embrace all learning; learning for its own sake and not merely as a means to prepare men for the practical duties of life, as in the professions. The higher education, the cultivation of the mental faculties is greatly needed in a new country like Canada with high aspirations, and efforts should be made towards this end throughout the Dominion. We want also Technical Schools, the old apprenticeship system has ceased to exist. Technical schools are needed to take their place, if our workmen are to be intelligent and to rank beside the skilled workmen of the United States and European countries. The workman of to-day must understand both the theory and practice of his calling and the Technical School alone will furnish him with what he needs as a foundation for these.

I occupy the position of the Chairman of the Protestant Committee of the Council of Public Instruction and I know the importance of what I advocate. Some of my Colleagues, present here to-day, will, I am sure be ready to confirm what I say, that the country needs a system of Technical Education.

Mr. Chancellor, I do not intend to make a long speech, in fact I am handicapped to some extent by the fact that I have almost lost my voice through a severe cold, but before concluding I wish to say a few words to the students now present.

Assembled as we are here to-day, of both sexes, young, middle-aged and old, we must recognize the fact that the future of Canada does not depend on the old, nor on the middle-aged, but on the young. If the young grow up with a spirit of loyalty to the Mother Country, of loyalty to Canada, if they will throw themselves heartily into the work of life, we shall have a race of men of sterling worth, ready to go forward in the path of liberty, with an intellectual capacity, which will make us proud of our country. But we must combine the cultivation of the body with that of the mind. This is done by the use of the athletic games, which I am always glad to see followed by our young men as being the means of cultivating a manly spirit. I wish them to remember that manliness and virtue mean precisely the same thing, and that he who wishes to become a true man, must take in the whole nature of man. I feel it to be a grand thing that the young men of this city engaged in the banks and in commerce are foremost in all the great games of football, hockey and similar pursuits.

The cultivation of a manly spirit is induced thereby. I would add that in my opinion this university has done a noble work in stimulating the mental growth of the women of Canada. The noble gift of Sir Donald Smith towards the higher education of women is of inestimable benefit. It is no new thing this higher education of women, for if we look back 300 years we shall find noble examples of the high intellectual attainments of women. We find Lady Jane Grey able to hold her own in theological argument with men of the highest intellectual rank of another religion.

We find Queen Elizabeth, herself a great queen and learned, with a well staid mind and trained intellect, able to guide the destinies of England through the tortuous mazes of an adverse and dangerous foreign policy.

I believe it to be our duty, in every possible way, to cultivate the intellect of woman as well as man. By so doing woman becomes more and more the helpmeet of man.

With these few remarks I resume my seat, wishing prosperity to McGill University and to the schools of Physics and Engineering.

DR. EGLESTON,

of the School of Mines, Columbia University, New York.

I am charged by the President of Columbia University to express his regret at not being able to be present, and to congratulate you on your having obtained this splendid equipment. I am an engineer, and I am proud of my profession. Owing to your great hospitality to the engineering profession, it has brought me into contact with and made me lifelong friends in Montreal. It has also brought me into the pleasantest relations with some of the Faculty of Applied Science of this Institution and I have thus been able to see its development almost from its birth. I came here some years ago and went around the city of Montreal with Prof. Bovey endeavoring to point out to some of the citizens the importance of testing machines and laboratories as factors in the progress of engineering science in the Dominion of Canada, endeavoring to raise money for the purchase of one of the testing machines now here. In this I failed but I went back to New York certain that the realization would some day come. The day has come and the realization has been far more magnificent than could have been anticipated. There is one thing, which I think has been lost sight of in the congratulations which have been presented to Mr. McDonald. He has generously given of his money, but he has really given a great deal more, for he has given his time and his personal interest even to the minutest detail. There is not a machine in this establishment, nor a belt in your shops, nor an instrument in the laboratory, nor a stone in your building, which has not had his interest, appreciation and closest attention. We are sometimes told we must cut the clothes according to the cloth, but there has been no such thing here, for I know that what he wanted was the best, not only then being constructed, but that could be produced. I have said "I am an engineer and am proud of it." For thirty years or more I have been e-ducating engineers in the School of Mines of New York. You will observe that I pronounced the word "e-ducation," which is the old pronunciation and the proper one, which explains the reason why engineers are admitted to be really a different class of men from those who have received an ordinary mental training. They have been e-ducated, that is to say, the powers which God has given them have been drawn out. The attempt has not been made to put something into them which, perhaps, they could not understand, but to bring out by the training of the ear, the eye and the hand, the abilities which God has given them, and which they are to apply. How much depends upon the accuracy of the training of the eye! An engineer going into a mine sees a little crack, it may, to an ordinary observer appear to be nothing, yet the mere observation of it may save a hundred lives, or he may see a slight change in the surface of the metal, which indicates to him the likelihood of rupture, which would escape an un-e-ducated eye, but which warns him of imminent danger. There is no power which gives the eye such an education as engineering training may be made to give. Then there is the power of the hand. An engine-driver ascertains by the simple trembling of a piece of machinery or by the rocking of his engine that something is wrong, and that if he does not seize the throttle-valve at once some lives will be lost. But we never thank him, it is an every day experience. But we do thank the engineer who goes into a mine and by just such a simple piece of observation saves a hundred lives, because we are less familiar with such occurences. Perhaps not many in this audience have ever thought it difficult to see what you look at, but in the majority of cases, unless you have been educated and unless the eye is trained, you may look at a thing year after year without really seeing it in such a way that you could either draw it or describe it accurately, because the imagination gives the idea; the reality is not there. I am very glad to see the realization here in this Dominion of the most perfect engineering and physical laboratories upon this continent. We shall have to look very sharp after our laurels in the United States, but we shall endeavor again to go ahead of you, as you have gone ahead of us now. But young men there is something else beside the mere acquirement of knowledge to be considered in your e-ducation. When you are e-ducated you get a great deal of learning, but learning is not necessarily wisdom. Job says: "the price of wisdom is above rubies," and he must have been inspired to write it, because a ruby above one carat is worth more than a diamond of that size. What is wisdom? It is not learning. Job says "the fear of the Lord, that is wisdom, and to depart from evil, that is understanding." If with your e-ducation you get wisdom, you will be sure to be the noble men you ought to be from having had all the advantages which, owing to Mr. McDonald's generosity, you can now get in this institution.

This terminated the ceremony, and His Excellency the Governor-General and party then inspected the various rooms in the building, afternoon tea being subsequently served in the elementary laboratory.

The ceremonies of the day were closed by a conversazione in the Engineering Building at which more than five thousand guests were present. During the evening Lord Stanley held a reception.

The whole of the machinery in the Laboratories and workshops was in operation.

The McDonald Engineering Building.

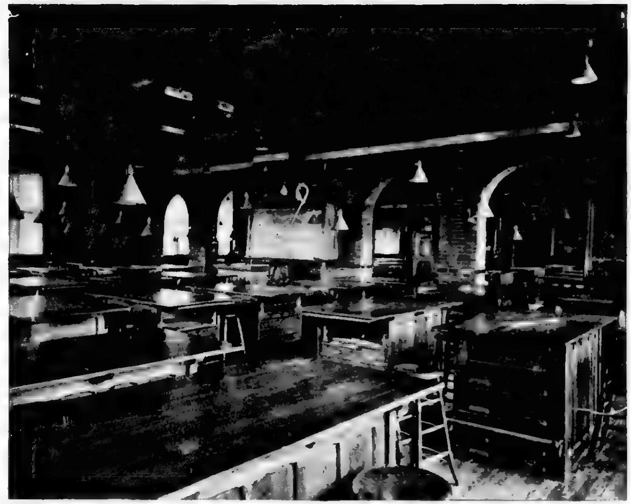
This building has been [illegible] the munificence of W. C. McDonald Esq., one of the Governors of the University.

The building is about 175 [illegible] in width, and has a basement [illegible] attic room in the roof.

In architectural effect it represents a severe treatment of the Italian Renaissance and [illegible] Montreal limestone, lined throughout with [illegible].

The whole of the building is ventilated by means of a Wing Fan in the Cupola of the building driven by a [illegible] Motor, which exhausts the air from each and every room through a series of vertical ducts in the wa[illegible] in the roof, from which it is ex[illegible].

The heating is effected by st[illegible]



DRAWING ROOMS

In the basement, below [illegible] found Worthington and Blake Duplex Steam Pumps for [illegible] connected with the testing machines.

The Ground Floor is [illegible] hydraulic laboratories, the lighting station, engine room containing [illegible] H. P. MacIntosh and Seymour engine for driving the [illegible] and thermodynamic laboratories. One half of the thermodynamic laboratory occupies two stories.

On the first floor are the [illegible] and mathematical and thermodynamic laboratories, the electrical workshops, the [illegible] engineering lecture room, private offices, cloak [illegible].

On the second floor are the magnetic laborator[illegible] mathematical, surveying and applied mechanics lecture rooms, the library (see page 15), instrument rooms, private offices, cloak-rooms [illegible].

The library is a very hands[illegible] four and five thousand books specially relating to the work carried on in the engineering building.

The whole of the third floor is taken up by [illegible] lighted drawing rooms, while the engineering museum occupies the whole of the fourth floor (see page 57).

HYDRAULIC LABORATORY.

This Laboratory contains a 28' by 5' by 5' square tank, perfectly flush on the inside and specially designed for investigations as to the action of water under low pressures.

The tank is provided with specially designed valves and gauges, which do not interfere in the slightest degree with the stream line flow, and by means of which variations in pressure in different horizontal sections and under different conditions of flow, can be observed with accuracy. The tank has also fixed to it a recording hydraulic gauge, which has been designed to make one, two, four, eight or twenty-four revolutions in a specified time.

The tank discharges into a water-course about 40 ft. long and 5 ft. wide. This course may be divided up into one, two or more compartments, each compartment being carefully calibrated so that the amount of the discharge can be easily estimated. At the end of the course, provision is made for inserting weirs of various forms and dimensions. Over these weirs the water flows into large measuring tanks, which have been carefully calibrated, and each of which has a capacity of about 250 cubic feet. The volume by weight of water in each of these, or in all the tanks, may be observed at a glance by means of an indicator on the wall of the laboratory.

Experimental work under high pressures up to 150 lbs. per square inch is rendered possible by a connection with the high level reservoir of the city.

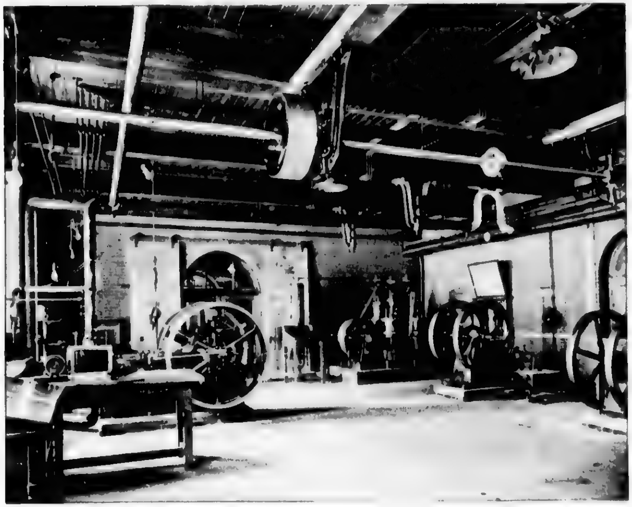
By means of a stand pipe with special fittings for pipes, nozzles, valves, etc investigations can be made under any pressure from zero up to the maximum. Any desired head may be kept constant by means of a water presure regulator, designed for this laboratory. Pipes from 6 in. in diameter downwards, can also be led from this stand pipe for a distance of about 60 feet, so that experiments on the frictional resistance to the flow of water in pipes, can be carried out under varying pressures and on a scale rarely before attempted.

Another special feature of this laboratory is an Impact Machine, designed by Prof. Bovey, for measuring the power and investigating the efficiency of water jets in combination with buckets of different forms and sizes. This apparatus is entirely new, and it is hoped that its use will not only serve to instruct, but will also open up a new field in the department of hydraulic co-efficients. It consists of a beam similarly arranged to that of a balance and supported upon knife edges in suitably shaped Vs. From one end of this beam and at right angles to it, there is an arm carrying at its extremity a sliding piece, which allows the arm to be lengthened or shortened, as may be desired. To the slide is attached a segment piece, which can turn round parallel to the axis of the beam. To this segment the bucket is attached and secured by a set screw. The extension and radial motions are indexed. A rack and pinion movement renders possible exact adjustments for radial and angular movements. The Vs in which the beams rest are supported on a cantilever fixed to the tank provided, by means of which the distance between the bucket and the jet may be adjusted as conditions may require. At the other end of the beam there is a cross-arm at the ends of which are suspended two buckets ; one of these buckets is used to adjust the turn of the beam, while water flows into the other bucket and supplements the weights required to counterbalance the turning moment due to the impact of the jet. One extremity of the cross-arm is also provided with a pointer, which moves in front of a scale, so that the measurements either by swing or by set balances can easily be effected

For surface measuring this laboratory has also been provided with a weir depthing machine. The laboratory is also to have a set of pumps specially designed for experimental work and research These pumps are to be adapted to work under all pressures up to 120 lbs. per square inch, and at all speeds up to the highest found practicable, with valves of the best kind and proportions. The set is to be composed of three vertical single action plunger pumps, each of 7" diameter by 18" stroke and driven by one shaft They are to have two interchangeable sets of valve chests, one being fitted with positive movement valves, and the other with small automatic valves. In each case it is to be so arranged that both the valves and their seats can be easily taken out of the chests and replaced by others. The power of the experimental pump at different speeds and under varying pressure, will be automatically recorded by means of a transmission dynamometer by Messrs. Amsler Lafon, of Schaffhausen. The impact and depthing machines were constructed by Messrs. Nalder Bros.

The equipment of the laboratory also includes a Venturi water meter, water meters of other kinds, gauges and gauge testers, and in fact all the apparatus necessary for the scientific investigation of the properties of water and water meters, and all kinds of hydraulic apparatus.

HYDRAULIC LABORATORY



THERMODYNAMIC LABORATORY.

The Thermodynamic Laboratory.

(FOR ILLUSTRATION OF EXPERIMENTAL ENGINE, SEE PAGE 35).

This laboratory, which is in connection with the subject of Heat engines, has a very notable equipment. The great feature of interest is the four cylinder steam engine arranged double tandem fashion and intended for use in a large number of totally different ways.

This magnificent machine designed by Messrs Schonheyder and Druitt Halpin, of London, under the general direction of Professor Carus-Wilson of McGill College, was manufactured by Messrs. Yates and Thom, Blackburn; and is extremely creditable in the results it has given to all concerned.

The engine may be described as a double tandem inverted direct acting quadruple expansion engine, to work at 200 lbs. pressure on the gauge, developing eighty horse power at about 150 revolutions. The cylinders of each Woolf engine are 6½" and 9," 13" and 18" diameters respectively; and the stroke of all 15" inches. The two engines may be uncoupled from each other and run at different rates of speed on the plan proposed by Mr. John I. Thornycroft and already carried out on the triple expansion engines at the Owens College, Manchester, and in this way, the advantages of variation of relative cylinder volume are to some extent obtained.

The measurement of the power delivered to the brakes is made by means of hydraulic brakes of the type designed by the late R. E. Froude, and improved by Prof. Osborne Reynolds.

One of these brakes is, in view of the disconnection spoken of above, fitted to each crank shaft; while an alternative method is supplied by an excellent rope brake kept cool by a stream of water on the inner side of the wheel rim on the plan first suggested by Mr. Halpin.

The steam pipes about the ders which are of copper are so arranged that the engines ma ither quadruple, triple, double, or single expansion. And as the pipes are led both to condenser and atmosphere, all these types may be tried either conden n-condensing. The method of exhausting into the condenser on all occasions, whether working with a vacuum or not, will, however, be adopted so that a double measurement of the water used by the engine may be made. The cylinders are all jacketed on the sides, top and bottom, and Willans' coils are also fitted to the low pressure cylinders. Variation of the clearance volume is made on the L. P. cylinder by pots having moveable pistons therein.

The system of measurement adopted is as follows: Having been weighed before entering the boiler, the steam used by the engine is tested just before entering the H. P. cylinder for its dryness by both a Peabody and a Barrus Calorimeter. Indicator cards may be taken not only from the cylinders but from the steam chests and intermediate receivers and about two-dozen of the best indicators have been supplied for this purpose.

The steam is discharged from the L. P. cylinder into a surface condenser, from which, when condensed, it is pumped by an air pump, worked either independently or from the main steam pipe into the measuring tanks where it is carefully weighed and its temperature taken. It then returns to the feed suction tank for use in the boiler again. On its way thither it will pass through four feed heaters, which are successively supplied with exhaust steam from the auxiliary engines, steam from the second and first receiver, and live steam from the boiler. In this way the feed is heated almost up to boiler temperature, and a saving (which was predicted on thermodynamic grounds by Prof. James H. Cotterill, in April, 1890,) is secured. This system has been tried practically also by Weir, in England, and Peck Wheeler in America, although in a very imperfect way.

The water from the steam jackets is weighed, and not as is usual estimated by the imperfect means usually employed, in a closed tank so that there is no loss by escaping steam. Four vessels standing a pressure of 200 lbs. received the water as it is condensed by radiation from the steam jackets. When observed to be full by the gauge glass attached, they are connected by a loose coupling with the closed tank on a weigh scale, and after the pressure has fallen to about 10 lbs. the water they contain runs completely out, and is carefully weighed in the closed tank after it has been disconnected.

The circulating water is weighed in two large tanks holding about 2000 lbs. of water, and in this way the accuracy of the Schonheyder water meter through which it also passes can be directly tested. The temperature of the incoming and outgoing water is read by delicate thermometers.

In this way, a complete balance sheet of the heat supplied, used, and rejected by the engines is made and the materials for the study of cylinder condensation by Hirn's analysis are ready to hand.

Steam is supplied to this engine by a water tube boiler of the Yarrow type as made for torpedo boats, of 120 horse power. This horse power can only be obtained under forced draught and when burning from 40 to 50 lbs. of coal per square foot of grate per hour. For this purpose this boiler is placed in a closed stokehold into which air is blown by a 5 H. P. Sturtevant Blower.

For pressures to 120 lbs., four 60 H. P. Babcock Wilcox boilers are available. Two of these are supplied with forced draft and completely fitted for testing; the other two are available for heating or power purposes.

The 10 by 12 Robb Armstrong automatic cut-off engine, and the 9 by 14 compound tandem, 16 stroke, by Laurie Bros., are also available for experimental purposes. They are completely fitted for testing and the heat balance for them can be as fully made out as for the quadruple engine since they are connected to the condenser.

A 10 H. P. Woodbury Merrill Stirling Type of hot air engine; a 6 H. P. Atkinson Cycle and a 4 H. P. Otto gas engine complete the equipment as far as prime movers are concerned but a 4 H. P. double air compressor for experimental purposes is in course of construction in the workshops, and will, it is hoped, soon be completed.

The third year laboratory contains apparatus for the demonstration of the properties of the permanent gases and of steam, and a complete set of the most modern types of pyrometers and thermometers, gauges, mercury columns, planimeters, calorimeters, render possible investigation of many problems which agitate the engineering world at the present time. The laboratory course is of two sessions in the third and fourth years.

In the third year, students of thermodynamics are taught the principles of the science by direct experiment; and original research is encouraged during the summer under the direction of the Professor.

In the fourth year, engine boiler and fuel testing is largely worked at; and the higher parts of the subject are explained by reference to the results obtained from the indicator card as measured and examined for moisture and heat exchange. The gas and hot air engines are tested again and again, and the effect of the different factors which modify results pointed out by careful observation.

Geodetic Laboratory.

While this Laboratory is primarily designed for the investigation of apparatus used in Geodetic and Surveying operations, it also affords the means of producing standards of length and of graduating circles.

The Laboratory is doubled walled, and the inner wall, which is of brick, contains an air space. In the basement there is an air chamber, from which hot or cold air may be supplied to the work room by a system of pipes. The air circulation is maintained by a fan which is driven by an electro-motor, at any required speed. When the desired temperature is reached all openings are closed, and a practically uniform temperature held for many hours. The instrumental equipment consists of:

1. A comparator for the investigation of standards of lengths up to 40 inches. The standard bar is of steel.

2. In connection with the Laboratory, but not in this room, there is also a 50 ft. comparator and unit of length, for the comparison of steel bands, chains, etc.

3. A circular dividing engine, designed especially with a view to the investigation of existing circles. The graduated circle is 30 in. in diameter.

These three instruments, and the standard bar, were constructed under the supervision of Professor W. A. Rogers.

4. A linear dividing engine (not shown in the photograph) which gives a cross stroke of 6 in. and graduates up to 42 in. The screw nut and bearings of this instrument are also by Rogers.

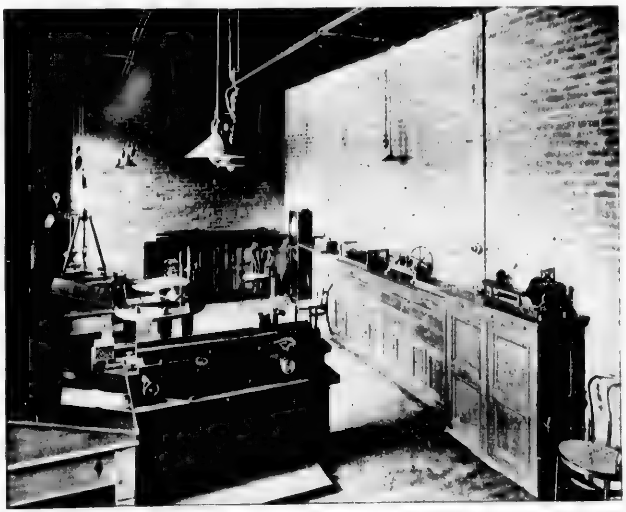
5. A portable Bessel's reversible pendulum, for the determination of gravity.

6. An astronomical clock, break-circuit chronometer and chronograph.

7. Level triers, end measuring gauges and minor instruments.

The equipment of Geodetic and Surveying instruments for the use of students consists of Transits and Transit Theodolites of various forms. Levels of the Dumpy Wye and precision types. Sextants for marine sounding and land work. Plane tables of English and American forms. Surveyors and Prismatic Compasses. Current Meters. An Altazimuth for triangulation work. A Zenith Telescope. Astronomical Transits. Amongst the latter should be specially mentioned the large instrument shown in the photograph on page 21. It is of the most recent design of the Russian or broken telescope tube pattern, is adapted for latitude work as a zenith telescope and has a clear aperture of three inches. In connection with the field astronomical outfit there is a break-circuit chronometer, and a chronograph.

There are also hand levels, chains, steel bands, tapes, barometers, pedometers, and other minor instruments required for the work.



GEODETIC LABORATORY

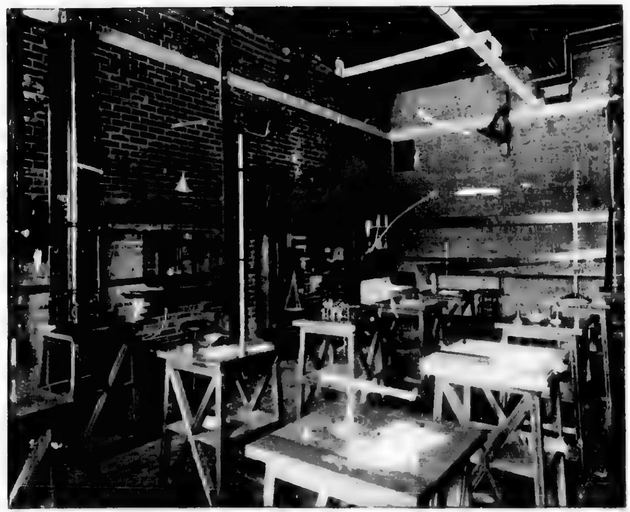
MATHEMATICAL LABORATORY

Mathematical Laboratory.

The course in Mathematics (which includes Kinematics and Dynamics) is conducted from the outset with special reference to the needs of students in Applied Science. Much time is given to practice in the use of Mathematical Tables, particular attention being paid to the solution of triangles, the tracing of curves, graphical representation of functions, the reduction of observations, methods of approximation, sources and relative importance of errors, etc. The laboratory adjoining the lecture room is liberally supplied with apparatus with which the student learns to make measurements of time, mass, distance, acceleration, and other quantities dealt with in the lectures, as well as to verify the fundamental laws of mechanics and to investigate various mathematical and dynamical constants. Special attention is directed to the general principles underlying the ordinary instruments of precision which are used in Physics, the simpler forms of these instruments being put into the hands of the student at an early period in his course. The experiments are in almost all cases quantitative, and the learner is encouraged to attain the greatest possible precision which the nature of the experiment and the instruments available admit of.

Among the more important articles in the laboratory may be mentioned:

For the measurement of time: Clock with seconds pendulum and electrical attachments, two water clocks, chronographs, stop-watch. *For the measurement of distance:* Scales of various kinds, screw micrometers, vernier calipers, cathetometer, reading microscopes. *For the measurement of mass:* Six chemical balances with which masses up to 10 pounds can be determined with the greatest possible accuracy, also spring balances. *For experiments on rectilinear motion:* Two Atwood machines, a Morin machine, inclined plane. *For experiments on circular motion:* Whirling table with various attachments. *Miscellaneous:* Pendulums (simple and compound), apparatus of various kinds for investigating harmonic motion, torsion balance with reading telescope, gyroscope, Maxwell's dynamical top, impact apparatus, mechanical powers, etc., barometers, thermometers, air pumps, specific gravity balances, hydrometers, planimeters, calculating machine, geometrical models, flasks, graduated vessels, etc.



MATHEMATICAL LABORATORY

Testing Laboratories.

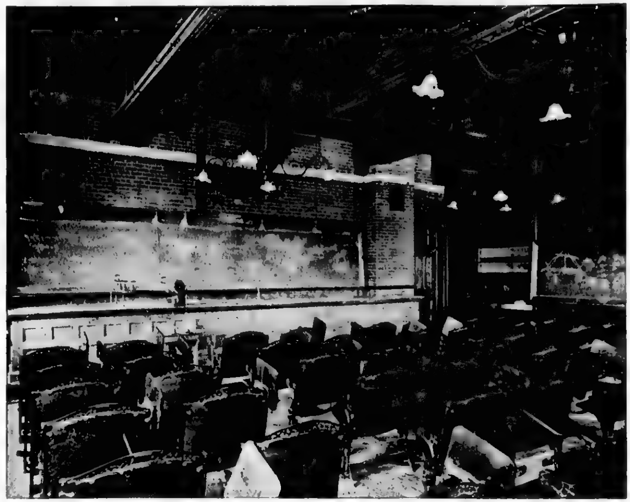
(FOR ILLUSTRATIONS OF TESTING MACHINES SEE PAGES 25 & 26)

These consist of two rooms each 60ft. by 30ft., with a basement of the same size. The main apparatus in these laboratories consists of :

A 75-ton EMERY TESTING MACHINE with a capacity for tension specimens up to 66 ins. in length, for compression specimens up to 85 ins. in length, and for transverse tests up to 60 ins. between bearings.

A 100-ton WICKSTEED TESTING MACHINE with a capacity for tension specimens up to 72ins., for compression specimens up to 48ins. in length by 10 ins. square. By means of an arrangement designed specially for this machine and having a capacity of one hundred thousand pounds strength of beams up to 25ft. in length by 10 ins. in width, by 24ins. in depth, may be determined.

The Emery and Wicksteed Machines are both worked from an hydraulic accumulator, which supplies either or both of the machines with a working pressure up to 3600 lbs. per square inch. The accumulator is charged by means of a set of Blake Pumps or a set of Worthington Pumps. The piping is also so arranged that the Emery Machine may be worked directly from the Blake or Worthington pumps, but when extreme accuracy is required, the testing machines are invariably worked from the Accumulator, as every pulsation of the pump is registered on the indicator. These two machines standing side by side in the same laboratory well illustrate the best types of English and American practice. The Wicksteed machine is also being provided with a self-registering apparatus similar to that used by Professor Martens in the Royal Laboratory, Germany. Since these machines have been installed many improvements have been made and the necessity for hand work has been altogether done away with. The raising and lowering of the heads is effected by means of electric motors; the scales are illuminated by electric reflectors, etc., etc.



APPLIED MECHANICS LECTURE ROOM

For measuring the deflections of beams under transverse loads, as well as the torsion and compression of materials under stresses the laboratory is provided with a specially designed Cathetometer, with Extensometers of various kinds (Martens, Marshal, Unwin), etc., etc.

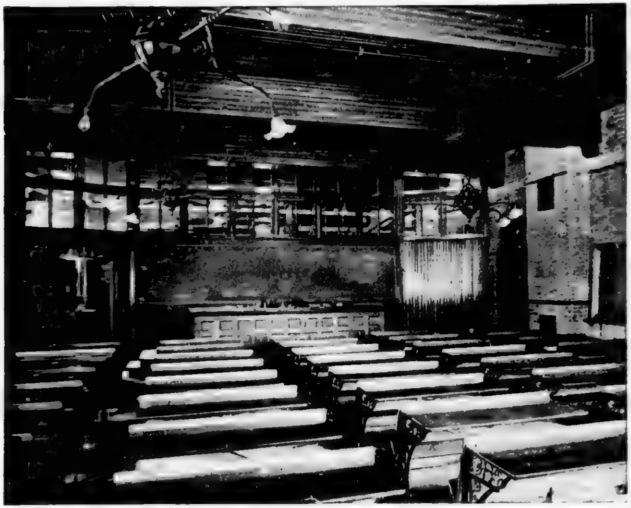
An UNWIN TESTING MACHINE for torsional, transverse and tensile testing.

THE ANGLE CATHETOMETER. This instrument was specially designed and elaborated for the testing laboratory by Messrs. Nalder Bros., from ideas suggested by Prof. Bovey, to enable accurate measurements to be made in connection with the use of horizontal types of torsion testing machines, and also to measure any deflections of a pointer moving about a horizontal axis, through an angle not exceeding 180°.

The apparatus consists of an ∠ sectioned arc of bell metal with an inlaid divided silver scale, over which moves a radius arm provided with a vernier. The arc is secured to a planed cast iron table mounted on levelling screws, upon which two sensitive levels are placed. To enable measurement at a distance to be accomplished, a telescope with cross wires, which can be adjusted axially, is provided. This arrangement permits of focussing the telescope upon a point more or less remote, and then rotating it in its screw bearings, and still keeping the intersection of the cross wires on the same point to which it was originally directed, in whatever position the radius arm may have been moved. At the further extremity of the arm is another telescope also with cross wires, which is held in a collar between centres whose line is in a plane parallel with the face of the arm; this permits the telescope to be directed on the extremity of a pointer which is under observation.

THE CATHETOMETER. This instrument as specially designed for the testing laboratory consists of a vertical steel cylinder supported on steel centres carried on a massive channel sectioned cast iron frame. Upon the cylindrical column there is a saddle carrying a large reading telescope supported on Vs, and on the collars of the telescope which rest on those Vs, there stands a large and very sensitive striding level. This telescope is levelled by means of the level above referred to, through the agency of two set screws of fine pitch which elevate or depress the telescope system as required and at the same time act as lock screws upon each other. The scale by means of which the values of the observations are determined is suspended in a ball and socket joint at its upper extremity, and is guided and restrained in a perpendicular position at its lower end by three set screws. This scale is a rectangular prism of platinoid divided into single millimetre divisions. It is made solid and square in order as far as possible to be homogeneous and free from distortion due to unequal expansions. It is made of platinoid, because that alloy does not readily oxidise. For similar reasons an inlaid scale of gold or platinum was not used. The scale is read by a microscope with cross wires and a pointer. The microscope is carried in a slide, which is directed against a micrometer screw by a spring. The micrometer screw which is of .5 mm pitch has a head divided into 100 parts. One division therefore represents .005 mm.

The whole saddle is counterweighted. To move the saddle with its reading telescope, a milled head operating a screw lifts or depresses it from the clamp which holds it in any position on the column. The clamp consists of a steel band embracing the tube and is tightened upon it by a screw moving its nut, which is attached to the column, outwards.



MATHEMATICAL LECTURE ROOM

[illegible] there are also an Oertling Bullion Balance [illegible] 125 [illegible] and down to 1/100 of a grain, and [illegible] up to [illegible] lbs, a Muir Lathe, a Shaping Machine [illegible] Machine are provided, so that all the apparatus [illegible] the specimens for testing is at hand.

[illegible] the above, the Laboratories are supplied with [illegible] of apparatus amongst which may be [illegible]

[illegible] Measuring Machine for measuring a variation of [illegible] of an inch; Sweet's Measuring Machine; [illegible] collection of Micrometers, Vernier [illegible], Depth Gauges, Rules, etc.

[illegible] TESTING LABORATORY. This Laboratory includes [illegible] Testers, a 1 ton Spring Tester (Faija), a [illegible] capacity of 50 tons, a Faija Tester for trans[illegible] apparatus, special weighing Hopper, [illegible] Moulds, etc., etc.

[illegible] personal error as much as possible the [illegible] by means of a Mechanical Mixer [illegible] speed by means of specially [illegible] The Laboratory is also provided with twenty large [illegible] may be submerged for [illegible]

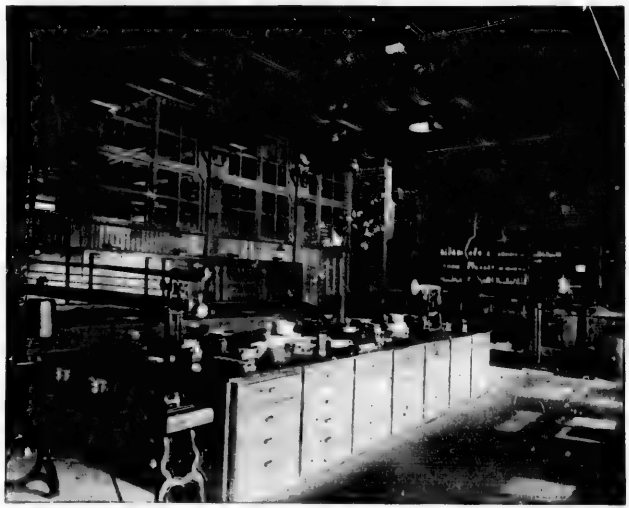
[illegible] the column by a slow motion [illegible] motion is provided, and the [illegible] rotated [illegible] upon the base [illegible] screws.

[illegible] mounted on the frame base for setting [illegible]

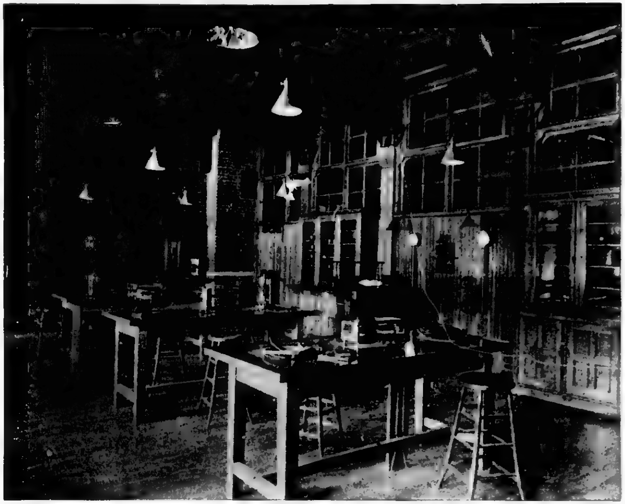
[illegible] constructed by Messrs. Nalder Bros. [illegible] work done by the [illegible]

[illegible] in the Laboratories [illegible] column reading up to [illegible] gauges, and with an Emery [illegible] 24,000 lbs. per square inch by [illegible] a specially designed record[illegible] variation of the pressure is shown [illegible]

[illegible] constructed fitted with revolving [illegible] deflections under rapidly [illegible] apparatus vibrate results [illegible] subjected to [illegible]



CEMENT TESTING LABORATORY



ELECTRICAL LABORATORY

Electrical Laboratory.

(FOR ILLUSTRATION OF LIGHTING STATION, SEE [illegible].)

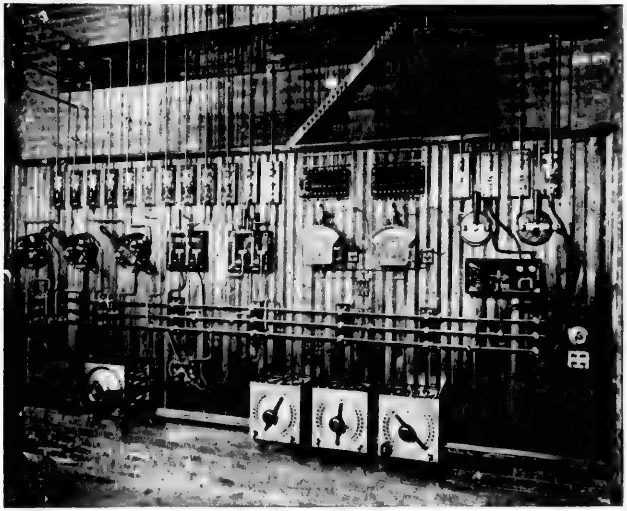
The Laboratories connected with the Electrical Engineering course consist of: 1 The Electrical Laboratory. [illegible] over the Dynamo Room and tests of dynamos may be conducted in it. Here are kept the standard instruments employed for calibrating the instruments in ordinary use. This laboratory is fitted with slate slabs firmly set into the walls, on which the more delicate instruments are placed. [illegible] to all parts of the room for experimental purposes, both from the lighting dynamos direct and also from the accumulators, so that current up to a thousand amperes may be obtained if necessary. The laboratory is fitted with a small bench for light work.

The instruments in this room comprise, amongst others: A Thomson galvanometer; two Thomson electric balances; four d'Arsonval galvanometers; two Siemens dynamometers; two Thomson electrostatic voltmeters; eight Weston ammeters and nine Weston voltmeters, of various ranges; an Evershed ohmmeter; two sets of resistance coils, English post office pattern; an Ayrton secohmmeter; several Nalder ammeters and voltmeters of different ranges; two standard ohms; standard cells, etc.

2. The Magnetic Laboratory is situated at a distance from the Dynamo Room and contains magnetic apparatus used in the laboratory course on magnetism and in tests of dynamos; the galvanometers are connected by wires with the dynamo room so that observations can be made which would be difficult in the neighbourhood of the dynamos. The apparatus consists in a ballistic galvanomometer, a magnetic curve tracer, Ewing's, in which the magnetic curves are exhibited on a large scale for illustration to the students and for investigation. There are also several pieces of apparatus made in the workshops, such as Hopkinson's Yoke, traction apparatus, etc., for illustrating the magnetic laws in every possible manner. Current is also laid on to this laboratory, from the accumulators, so that a steady current may be available for delicate tests.

3. The Photometer Room. Here tests are made of the illuminating power and efficiency of lamps, by means of a standard apparatus, using the Bunsen disc. Current is laid and the electric observations are read by means of a wattmeter.

4. The Electrical Workshop. This is fitted up for making electrical instruments of all kinds; there is a very fine lathe by the American Watch Tool Company driven by a ½ horse power Crocker Wheeler motor. This lathe was selected with a view to turning out fine work if necessary, and has already done good service in this direction.



SWITCHBOARD

6. The Lighting Station. This is in every respect typical of the best English and American practice. There are two dynamos, a 3[illegible] K. W. Siemens and a 30 K. W. Edison Hopkinson, each being driven direct by a Willans engine running at 450 revolutions per minute; these engines are each double tandem compound single acting. The smooth running is largely due to an elastic cushion of compressed air that acts as a buffer at the end of each stroke; as the engines are single acting there is no knocking whatever, however loose the brasses may be.

Each engine and dynamo of six hundred lights capacity, takes a floor space of about [illegible].

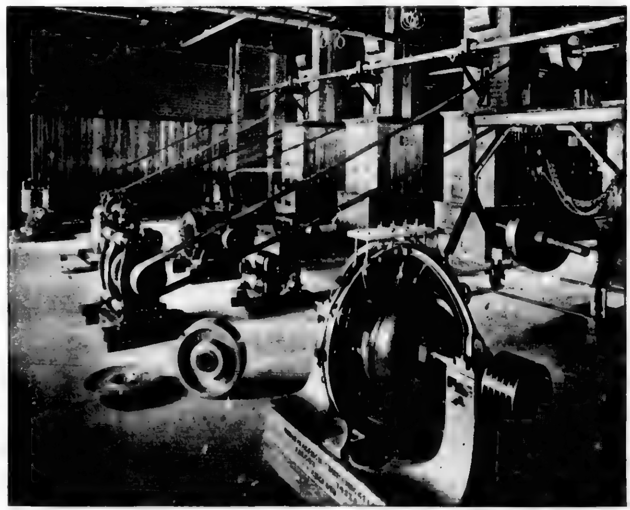
The switchboard was made in the college workshops. F and H[illegible] switches are used, also English double throw switches and Weston instruments. The lighting system is the three wire, but the [illegible] can be coupled up so that one dynamo can run half the lights on the two wire system; then, when the load is increased, the second dynamo is switched on in series and the lights run three wire.

One voltmeter serves to give the voltage on all the circuits, and one ammeter [illegible] is only required for nine different circuits; the current is measured by the fall of potential method and the different [illegible] are all connected to the same instrument by means of a sliding switch.

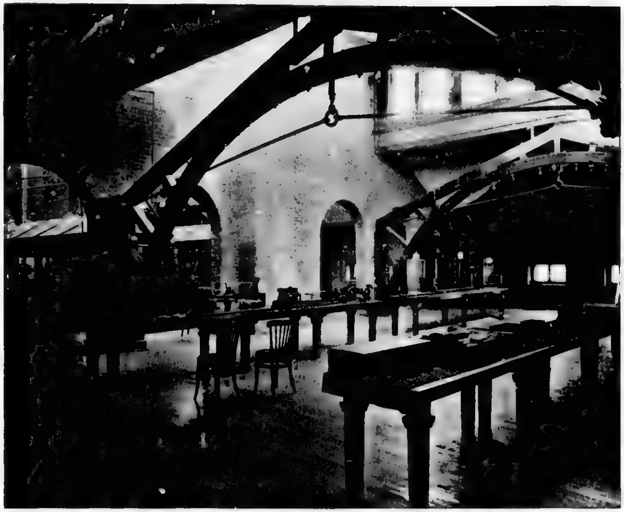
A Nevile safety cut out is used in charging the accumulators, so that when the voltage falls too low the circuit is broken, but is remade automatically when the voltage rises again.

7. The accumulator room contains Crompton Howell cells of a total capacity of eight hundred ampère hours.

5. The Dynamo Room. [illegible] 25 K. W. [illegible] 12 K. W. Mather [illegible]



DYNAMO ROOM



MUSEUM

MUSEUM.

The Engineering Museum occupies the whole of the top floor and embraces an area of about [illegible] square feet. The most notable feature in this room is a splendid and unique collection of models, known as the Reuleaux Kinematic Collection. Here almost every conceivable form of mechanical movement is represented, and the excellency of workmanship and beauty of design are due especially to the fact that Prof. Reuleaux, so well known all over the world, himself kindly supervised the formation of the different sets.

Prof. Reuleaux of the Berlin Polytechnic is so well known both in Europe and America that more than a passing reference to him need not here be made. He has devoted his life to the elaboration of a new science, viz., that of Applied Kinematics, or Mechanism.

This science was defined by the great physicist Ampère and put in its correct place as one of the exact sciences in his "Essai sur la Philosophie des Sciences," [illegible].

Leupold, Monge, Carnot, Lang, [illegible] and Poncelet spent considerable thought on the subject, while Willis of Cambridge devoted a large treatise bearing the mark of careful and earnest investigation, to the classification of mechanisms.

Reuleaux by his epoch making work "Kinematics" revolutionized the science and introduced a splendid orderliness where before nothing but confusion had reigned.

He was the first to produce new mechanisms from old ones by reference to the method of his scientific inquiry alone, and he alone was enabled by means of his new method to furnish the means of producing any required kind of motion; thus ridding the subject of the charge of empiricism and enabling it to deserve the name of a science.

The magnificent collection in this museum is the embodiment of Reuleaux' new science; it is not a mere large collection of well known mechanical movements. It is the exemplification of the evolution of lower and higher mechanisms from their elements; in the same way as chemical compounds are shown to be built up from their constitutent simple molecules.

The collection embraces certain models which have never before been made, for examble, the Globoids, most ingenious in construction and of great theoretical value, and the Cycloids, which are totally new. Again, the collection includes models for sinoid and other motions, the models showing step by step all the properties of curvilinear movements; models illustrating parallel motions and rectilinear motions. Also models illustrating cyclic rope transmission, pendulum movements, etc., etc.

Besides this Kinematic Collection, there are also trusses of different types, illustrating the manner in which different loads [illegible] the several members of a truss. This method of illustration was first adopted in this University in the year 1879. The comparative magnitudes of the stresses are estimated by means of spring scales introduced in the different members of the truss. Sectional models of engines, locomotives, etc., showing the working parts are also to be found here, together with a collection of cable specimens from leading manufacturers in Europe and America. An economic collection is also being formed and already embraces many materials of construction and materials employed in the arts, of great value and interest. The museum also contains a splendid collection of working mining models, illustrating the different methods of mining both in this country and in Europe.

MUSEUM

WOOD-TURNING AND PATTERN-MAKING SHOP.

CARPENTER'S SHOP

The Mechanical Workshops erected on the Thomas Workman Endowment, consists of two floors, a ground floor and a basement, having a total area of nearly 25,000 sq. feet.

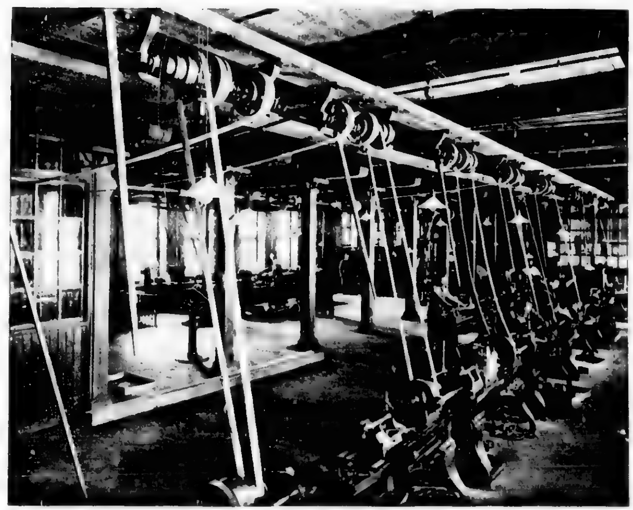
The practical instruction in the workshops is solely designed to give the Student some knowledge of the nature of the materials of construction, to familiarize him with the more important hand and machine tools, and to give him some manual skill in the use of the same. For this purpose, the Student, during a specified number of hours per week, will work in the shops under the direct superintendence of the Professor of Mechanical Engineering, aided by skilled mechanics. The courses commence with graded exercises and gradually lead up to the making of joints, members of structures, frames, etc., finally concluding in the iron-working department with the manufacture of tools, parts of machines, and if possible, with the building of complete machines.

The Carpenter's Shop occupies the whole of the top storey, the accommodation being sufficient for about seventy students. Here the freshmen commence their practical work. They next receive instruction in the wood turning and pattern shop, which occupies the whole of the first floor, accommodation being provided for about fifty students.

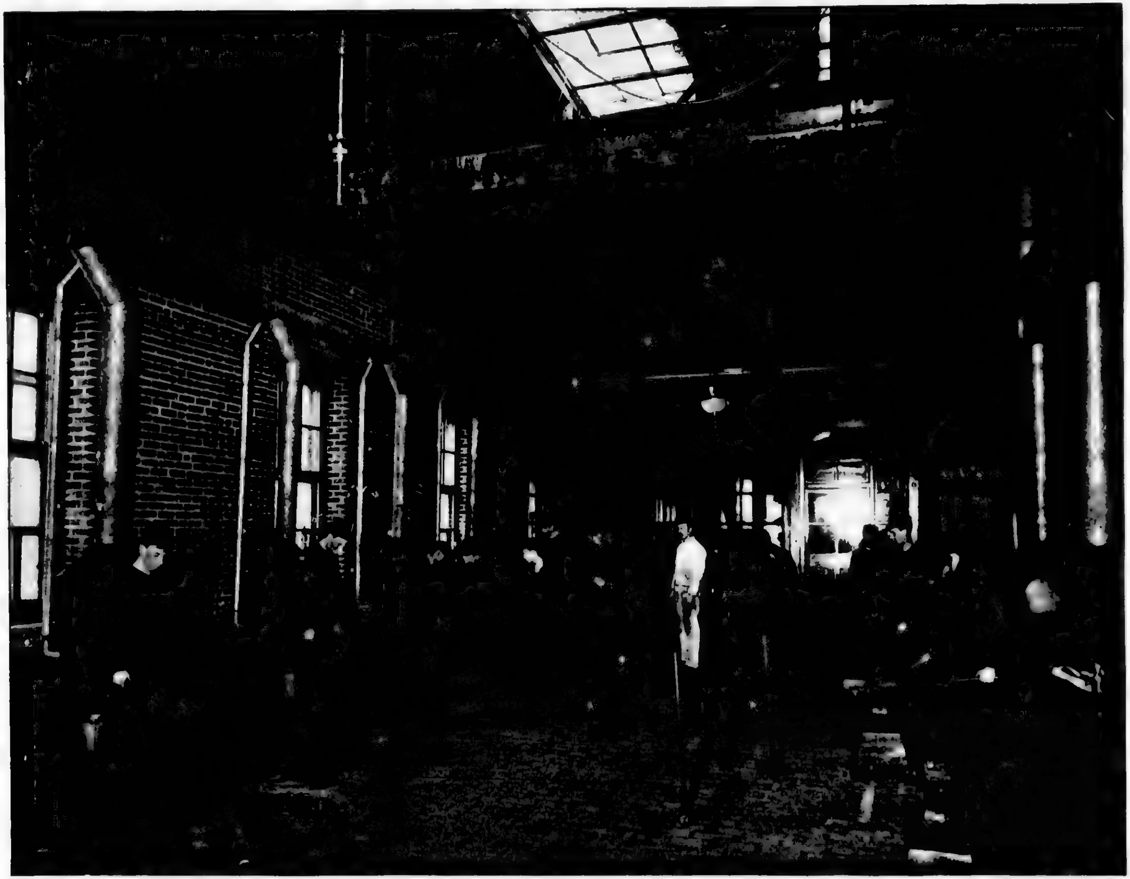
The Machine Shop and Engine Room occupy the whole of the ground floor. This department has an extremely good equipment including twelve metal lathes for the special use of students, one large centre lathe, planing, shaping, universal milling, drilling and tapping machines, and all necessary centering and grinding machines. The shop which is also used for fitting, contains seventeen vises and a very complete assortment of tools. All the machinery consists of types selected from the best manufacturers in England and America. Students work in this shop in the Third and Fourth Years, the accommodation being sufficient for about thirty-five students working at one and the same time.

The other half of the Second Year is spent in the Foundry, which contains cupola, core oven, brass and annealing gas furnaces, brass moulding and iron moulding benches, core benches, travelling crane, and all ladles and other apparatus necessary for the complete instruction of the students in the moulding and casting of simple machine parts. Their foundry instraction designedly precedesnis work in pattern making as this been found to give the best results. There is sufficient accommodation in the Foundry for twenty men.

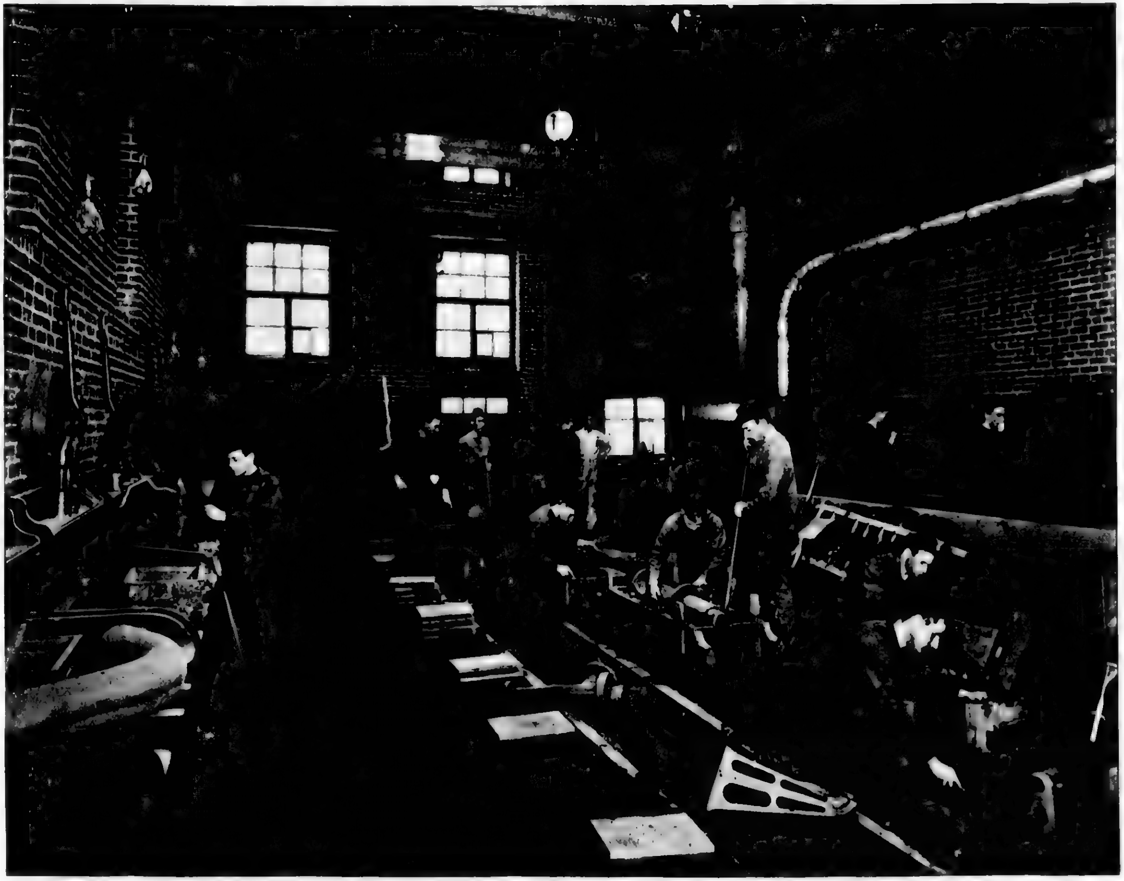
The remainder of the basement is occupied by the boiler and coal houses, fans, blowing engine, pumps, store rooms for patterns, etc., etc.



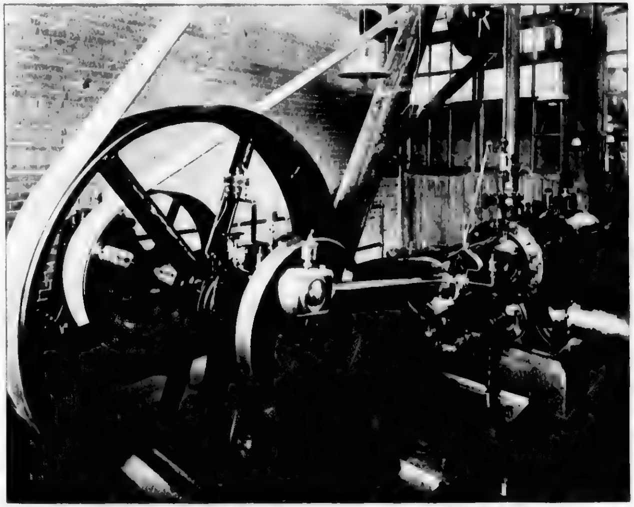
MACHINE SHOP



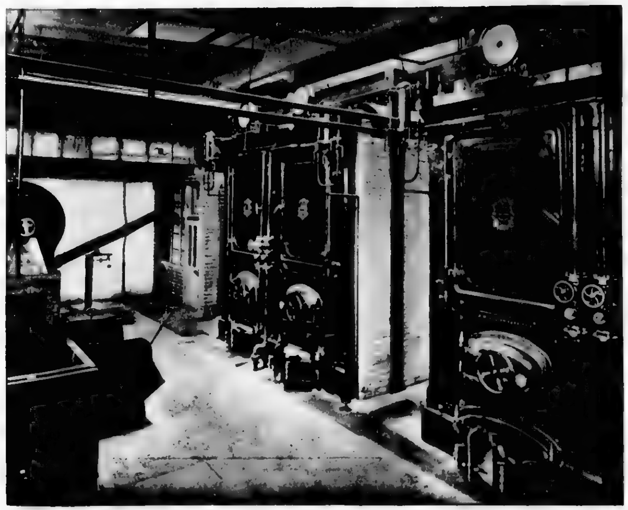
SMITHY.



FOUNDRY



SHOP ENGINE



BOILERS

ENTRANCE HALL

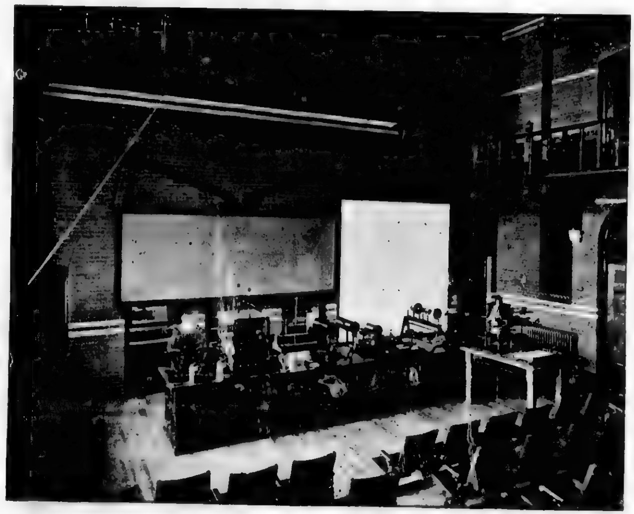
The McDonald Physics Building.

This Building has also been erected and equipped through the munificence of W. C. Macdonald, Esq., for the Teaching and Study of Physics (including Mechanics) with special regard to (1) its intrinsic importance as an integral part of a liberal education in the Faculty of Arts, (2) its essential necessity as a study preliminary to the courses of Engineering, Mining and Practical Chemistry in the Faculty of Applied Science, and (3) the prosecution of original research.

The Building is 125 feet long and 64 feet wide, and has five stories besides a range of attics, used for storage, in the mansard roof. It is in the Romanesque style, massively constructed of cut Montreal limestone lined with pressed brick, all brick edges being rounded. No plaster is used in the interior except in the small rooms occupied by the Janitor. An excellent foundation on the boulder clay was reached by the removal of nearly 2[illegible] feet of soft clay. In spite of the great weight of the walls, which are three feet thick at the base, no settlement has been observed. On the slow-combustion principle the floors are of solid wood four inches thick, the upper inch being hardwood (maple), and are supported by heavy oak beams without the use of girders. The staircase, apparatus cases, library and lecture theatre are in quartered oak.

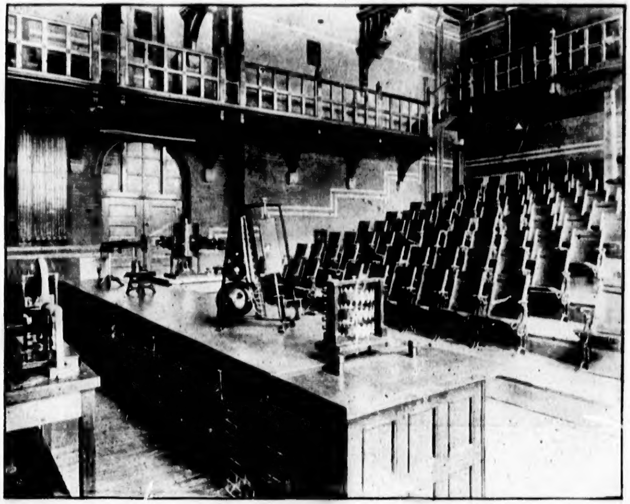
From the fall of the ground, access to the Building is by the Porch in the centre of the eastern side midway between the second and third floors. The entrance is laid with marble mosaic and has a fine carved sandstone fireplace with the motto "Prove all Things". The staircase is reached through an archway on the left, and at this level a mezzanine floor affords an office for the Janitor, a cloak room, and a sitting room for Students. The stairs lead downward to the two lower stories devoted to advanced work and research; and upwards by half a flight to the main (or third) floor, where, immediately on the left, is the door of the principal Lecture Theatre. The corridor ten feet wide, as on all the floors opens at the opposite, or northern end into the Laboratory for heat and calorimetry, which is 64 feet by 34 feet. Between these are the main apparatus-room, the office of the Professor of Physics, and a room for private research.

The Lecture Theatre, occupies two stories and is 30 feet high. It has a floor space of 46 by 36 feet and seated for 140, with a gallery which gives accommodation for 60 more. Its acoustic properties have proved excellent. The table is of Rockland slate, 20 feet, by 3 feet 6 inches, by 2 inches, supported on brick piers, which are carried down to an independent foundation through the two lower stories. It is encased without



LECTURE THEATRE

contact by a firm structure in quartered oak, which carries gas and water pipes, and has sinks at each end. The lids of the sinks are countersunk, and the stand-pipes are jointed, and bend down into the sinks, so that when they are not in use the whole surface of the table is available. Gas brackets are set every few feet beneath the projecting edge of the table with double jointed arms, so that they can be brought up over the top when required. Binding posts are set all round giving connection with the electric mains, or with the fume-closets behind the table as desired. Currents can thus be drawn at 95 or 190 volts direct from the three-wire system: or at lower voltages through a series of lamps inserted beneath the table; or from primary batteries in the fume-closets. The table is also supplied with oxygen and hydrogen, each under pressure up to 10 atmospheres, air-blast and exhaust. At the southern end are two heliostat windows: or a beam of sunlight may be brought in on the floor below, and reflected vertically upward to the table. The back wall has a lofty gallery for suspension, which may also be effected from a roof-truss reached through a trap-door over the table. The black-board (which is 14 feet by 5 feet, of ground plate-glass backed with black or white cloth at will, and which, the cloth being removed, is available as a ground glass screen for projections from the preparation-room behind) is suspended (after Professor Perry's plan) by two levers on bearings. It weighs, with its counterpoise, nearly 2,000 lbs., but is found to be easily manageable. It swings in front of three fume-closets, supplied with slate tables, gas, and electricity, the centre table being moveable, so that it may be rolled through from the Preparation Room to the main table when the sashes are raised.



LECTURE THEATRE

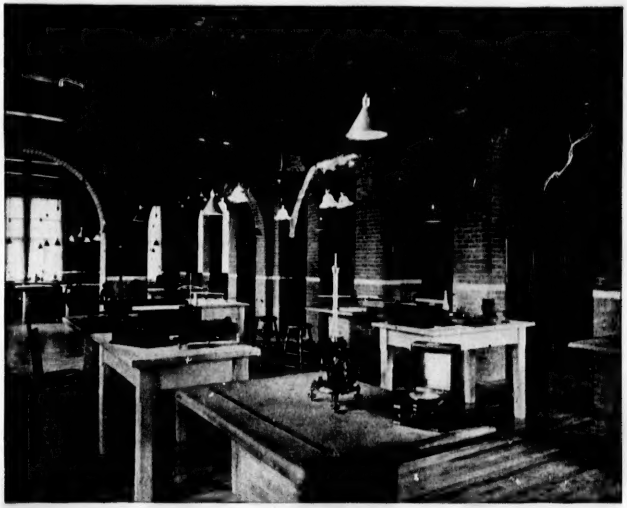
LIBRARY.

The Theatre is lighted from the roof by 90 incandescent lamps, 20 of which form a border over the diagram frames, black-board and lecture table. Space is reserved for a 10 foot screen of adamantine cement for projection, and electric and oxyhydrogen connections are arranged to a table under the back gallery, where the lantern may be placed when it is desired to use the large roller screen above the black board. All the lights are controlled from switches at the north end of the table, and the black blinds for darkening the room can be simultaneously raised or lowered by a small hydraulic cylinder and multiplying pulleys operated from a four-way cock.

The Preparation Room opens directly into the principal Apparatus Room, where the instruments used in illustrating lectures are stored. The cases and wall-cases are in quartered oak; the doors close upon felt strips, and the tops have ventilators packed with cotton wool to arrest dust.

From the apparatus Room, or by the corridor, the Heat Laboratory is reached. This room is supplied, as well as all the laboratories, with sinks, fume-closets, water, gas, current from the electric mains, vacuum pumps, drying ovens and slate working-benches, supported on corbels from the walls independently of the floor. It has also oxygen and coal-gas under pressure, and steam supplied from a small boiler.

The Fourth Floor, next above, contains, besides the upper part of the Lecture Theatre and reserve apparatus-room already mentioned, a lecture room seating about 40, for advanced classes, a cloak-room for women students, a special Library of Physics, and a suite of rooms for the Department of Mechanics.



ELECTRICAL LABORATORY.

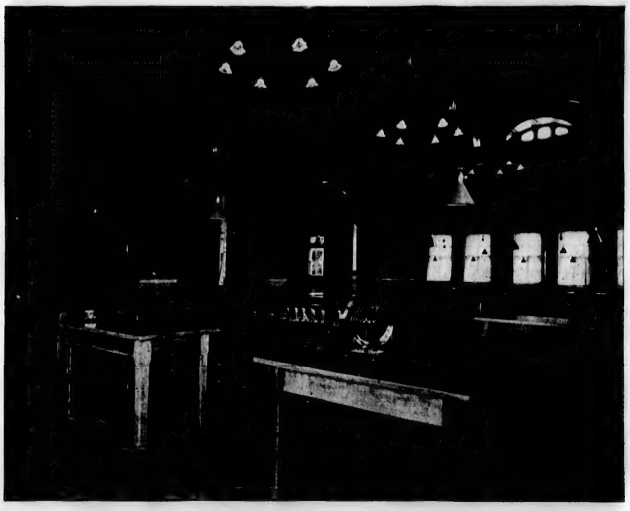
The Mechanics' Lecture Room will seat 80. It can be darkened, and the Lecture Table is supplied with electric current, gas, water, air blast and exhaust, and special sinks for experiments in hydrostatics. There is a heliostat window at the eastern end of the table: the special apparatus room, leading to the Professor's private room, opens behind it.

The highest floor contains, at the south end, a range of rooms devoted to Optics. There is a large room specially planned for a Rowland six-inch concave grating, with separate dark room; a set of three small rooms for spectroscope and optical bench work; a circular room in the turret for spectrometers; and a long narrow room for photographic enlargements. All these rooms have arrangements for darkening, heliostat slabs accessible by an external gallery, electric connections for arc or incandescent light, gas and water. The rest of the floor is occupied by a large Elementary Laboratory, 64 feet by 54 feet, with a private room for a Demonstrator, and a separate room which can be darkened for experiments in Optics or with mirror galvanometers. The Elementary Laboratory has a fine open roof, magnificent lighting, and easy access to the outer air by two doors leading to galleries on each side of the Building. From these, or from the roof above, magnificent views may be obtained of Mount Royal, the City of Montreal, the St. Lawrence, and the country to the South stretching away to the Green Mountains and the Adirondacks.

The Basement may next be reached either by the staircase (the well of which affords a vertical suspension of 80 feet accessible at all levels), or by the hydraulic lift, which has been placed conveniently near the store-rooms in the roof, the apparatus-rooms, workshop, and goods entrance on the lowest floor. Its tower carries the electric mains. The south end of the basement contains a room for optical work requiring great stability; the coal-cellars, supplied by a shoot from the road; and the furnaces for heating. These are four in number, and can be used singly or in combination. The heating is by hot water circulating through radiators. At the north end are the Magnetic and Research Laboratories. The floor is laid in Portland Cement covered with asphalt. The drains, water and gas mains are enclosed in trenches covered with open gratings which can be raised at any moment, and all pipes are open to view throughout the Building.

In addition to the usual slate tables, on the walls numerous brick piers have been erected on independent foundations, separated from the asphalt floor by a space 2 feet 6 inches wide packed with sand. The piers are joined in the basement by long slate slabs affording ample table space free from disturbance. The tops of the piers project through the floor to the Advanced Electrical Laboratory above, where they support square slabs of slate. A portion of the Research Laboratory is continued upwards though the floor above, so as to give a vertical height of 30 feet: The upper space is separated from the Electrical Laboratory by glass partitions which give easy access to it. The Casement also contains two rooms for Uniform Temperature, one beneath the Entrance Hall, practically underground, the other lighted from the north, but enclosed in double walls, floor and ceiling, and surrounded by a passage two feet wide which can be maintained at any temperature within moderate limits.

The second floor has, at the south end, (1) Students' Lavatories; (2) a range of 100 separate lockers giving hanging accommodation for winter coats, etc., which, being immediately over the furnaces are practically drying cupboards; (3) a workshop, 40 feet by 18 feet, containing a universal milling machine,



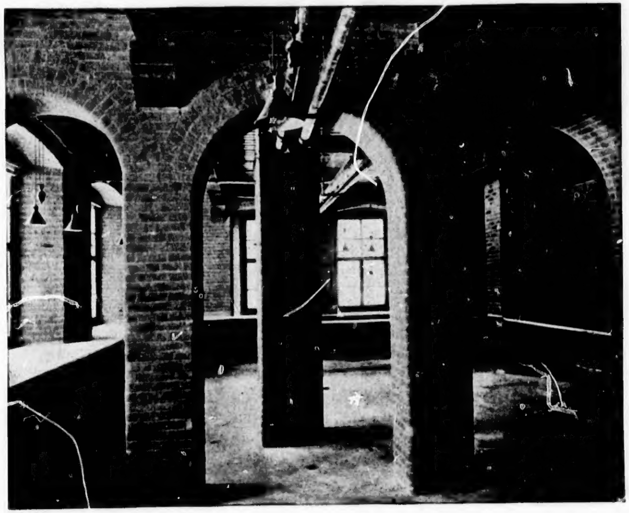
ELECTRICAL LABORATORY.

engine-lathe, wood-lathe, instrument maker's lathe, carpenter's and fitter's bench, etc. In this room is set up an ingenious arrangement of oxygen and hydrogen tanks which can be filled, according to the plan suggested by Mr. G. Prowse, of Montreal, up to a pressure of 10 atmospheres, without any pumping engine, by means of the high water pressure (160 lbs) in the service mains. The gases are led from the cylinders to the Lecture Theatre and Heat and Research Laboratories.

The north end of this floor contains the Advanced Electrical Laboratory, which is provided with a large amount of slate table partly out from the walls, and partly supported on the piers rising from the Research Laboratory beneath. Deep slots in the walls connect the principal Laboratories (Heat, Electrical, Research and Magnetic,) and carry circuits of heavy wire by which instruments in any of the rooms may be joined up in series, or parallel, or grounded. A long and dark photometer room runs beneath the Entrance Hall and Porch, and there are two separate smaller rooms provided with solid piers, intended for private use in research.

The Entrance Hall is regained by ascending half a flight of the staircase.

It remains to mention that the ventilation is by flues gathered to a fan in the turret, driven by a 5 H. P. Motor. The lighting is throughout by incandescent lamps supplied with direct current. In the Laboratories single lamps are adjustable over all the work tables, in addition to the pendents provided for general lighting. The current for lighting and for driving the motors in the workshop is supplied from the Macdonald Engineering Building. It will thus be seen that all the inconveniences arising from the presence of steam or gas engines in a Physical Laboratory are avoided, while the generation and storage batteries are naturally under the



RESEARCH LABORATORY.

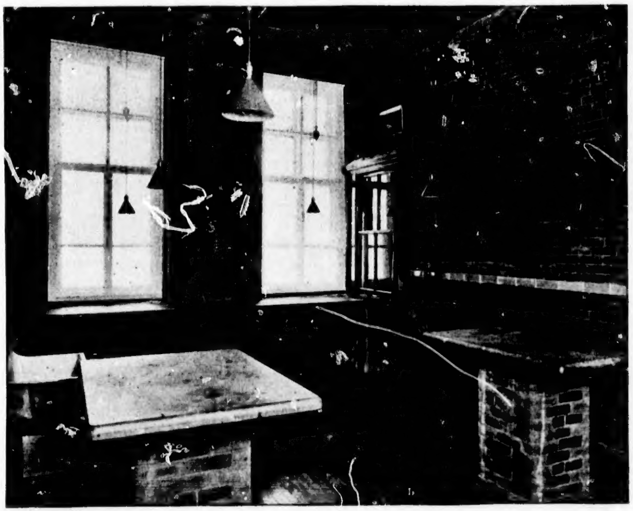
care of the Department of Electrical Engineering. In order to further save the work in Electricity and Magnetism from disturbance, the two lower floors over the northern half of the Building have been constructed entirely without iron. Doubtless the most important point was to allow no iron which could be subject to changes of temperature, as in the heating coils and radiators. These are accordingly of copper; but it was thought worth while to carry the arrangement to completion down to the nails of the flooring, and the lock, window and electric light fittings.

EQUIPMENT.

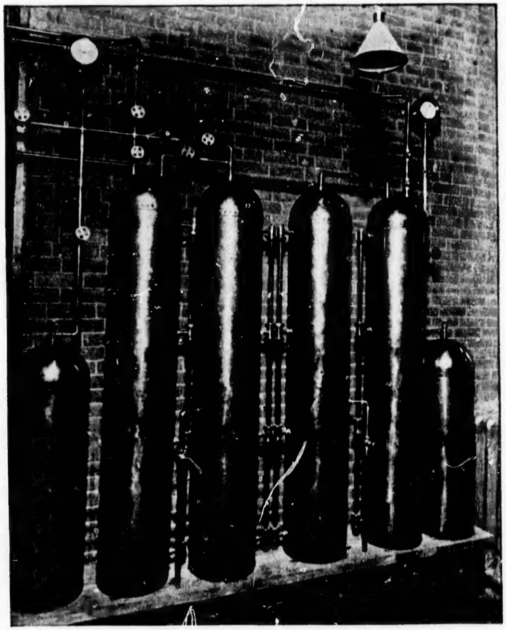
The instruments have been chosen on a scale corresponding with the building to serve three purposes—(1) Illustration of Lectures, (2) Elementary Practical work by the students, (3) Advanced work by Fourth Year Students and Graduates and Private Research. The general principle has been not to select special arrangements for particular experiments except in the case of those classical experiments which have a historical interest of their own; but to secure a very complete supply of fundamental instruments which are always in request, and from which any particular case can be built up. It must suffice to name a few typical instances under each head.

(1) ILLUSTRATION OF LECTURES.

The projection apparatus is very complete, including a Newton Electric Lantern similar to that used in the Royal Institution, London, with diagram, spectrum, and microscope fronts. The latter is of the Lewis Wright pattern, and there is a separate Lewis Wright polariscope with a polarizing nicol of 2½" clear aperture. The Brockie-Pell arc lamp with inclined carbons has given great satisfaction. It is steady, noiseless, and focus-keeping, and has



PRIVATE RESEARCH LABORATORY.



GAS COMPRESSING TANKS.

yielded at one photometric test as much as 3070 candles. There are two other lanterns and a projecting optical bench by Schmidt and Haensch, of Berlin, which serves admirably for demonstration. In acoustics, there is a fine collection including many of the principal instruments made by Dr. Koenig, who has supplied all the work in this department. The electrical instruments include a beautiful twelve-plate Wimshurst machine made under Mr. Wimshurst's superintendence for the Chilian Government, a four-plate Holy, induction coils by Ruhmkorff and Apps, Lecture Galvanometers, Electrometers, etc.

(2) ELEMENTARY PRACTICAL WORK.

The first year's work is devoted to measurements of length (micrometer gauges, callipers, spherometers, cathetometers, various types of reading microscopes) time (pendulums and gravitation, chronographs) mass (there are six balances by Oertling, six by Becker, two by Troemner), specific gravity (Joly's and Moher's balances) moments of inertria and co-efficients of elasticity (Maxwell's Needle); thermometry and simple calorimetry; simple photometry, properties of lenses; spectroscopes and spectrometers by the Geneva Society, Schmidt and Haensch, and the Cambridge Scientific Instrument Co. For elementary electricity there is a large number of simple resistance boxes by Halder Bros. accurate to 1/8 of one per cent. several metre bridges, potentiometer tangent and zinc galvanometers, of different patterns, Mather galvanometers, Ayrton voltameters, quadrant electrometers, seven d'Arsonval galvanometers and two post office boxes by Elliott and Halder.

(3) INSTRUMENTS OF PRECISION.

Only a few of the principal can be named. Standard bars, linear and circular dividing engines and comparator have been supplied by the Geneva Society, and the laboratory has the advantage of reference to the beautiful Rogers instruments in the Geodetic Laboratory of the Macdonald Engineering Building. There is a time circuit from the observatory for regulating the clocks and pendulums. Besides a Regnault timing-fork chronograph by Koenig, there is another by Edelmann, one by Fauth which has already been satisfactorily employed in the recent direct determination of longitude between Montreal and Greenwich, and much recording apparatus from the Cambridge Instrument Company Two large automatic Sprengel mercury pumps by Max Stuhl, of Berlin; Cailletet's apparatus for compressing gases; two Boys' radiomicrometers, Cathetometer, and Rayleigh reading microscopes by the Cambridge Company, deserve mention.

In electricity the principal features are the set of thirteen certified standard coils by Halder (ten units, one ten-ohm, one hundred and one thousand), a coil in mangavin and the splendid set of resistance boxes by Halder and Elliott, including complete sets up to the megohm both in platinum silver and German silver, many sets of plain coils and bridges, multiple-arc box, dial-pattern bridges with four and six dials, and Thompson Vermier coils. All the principal boxes are made with solid brass sides to avoid warping. For standardising coils there is a duplicate of the Fleming bridge in use at Cambridge, England, presented by the Chancellor of Cambridge University, the late duke of Devonshire; and Halder's pattern of the Carey-Foster bridge and commutator. All these resistances and standards are in True Ohms.

Among the Galvanometers may be noted eight Thomson square pattern reflecting galvanometers, including one of 100,000 ohms resistance, and two tripods, by Halder; a large Wiedemann Kohlrausch standard Tangent, and Absolute Galvanometer (by Hartmann and Braun); large Edelmann (by Dr. Edelmann, who also supplies an earth inductor, magnetometers, and quadrant electrometer, and has kindly presented an Uppenborn's galvanometer); and many others of the first class; Kohlrausch patterns of magnetometers and Variometers (Hartmann and Braun); Kew Magnetometer and Dip Circle; Thomson Absolute and Quadrant Electrometers, (Elliott); Ewing's Magnetic Curve Tower, Hopkinson Peribeometer, Ayrton-Mather-Sumpner Quadrant Electrometer, British Association Standard Air Condenser and Standard Electrodynamometer (Halder); Electrodynamometer (Siemens); Condensers, (1/3 micro farads and divided farads by Halder and Elliott).

The optical instruments include a Clifton pattern Gonometer with six reading microscopes (Elliott); spectrometers by the Geneva Society (with quartz train) and Schmidt and Haensch (V Lang pattern). This firm also supplies a Lummer-Brodhun portable photometer; the same arranged for a bench; the new spectro-photometer with Lummer-Brodhun prism; and a very perfect Landolt Polariscope with two reading microscopes, and special arrangements for rotation of plane by powerful currents. The two latter instruments have been recently designed for the Berlin Physikalisches Institut.

The above list, though only naming the principal types of instrument, will serve to indicate the extent and variety of the whole collection.